SCIENTIFIC AMERICAN SUPPLEMENT

Copyright 1917 by Munn & Co., Inc.

VOLUME LXXXIII] NUMBER 2152 ★ NEW YORK, MARCH 31, 1917 ★ [10 CENTS A COP $5.00 A YEAR

Women munitions workers operating drilling machines in a Canadian factory

NEW WORK FOR WOMEN CREATED BY THE WAR [See page 200]

World Wide Changes of Temperature*

Can Seasonal Forecasts Be Made from a Study of the Weather of the World?

By Charles F. Brooks, Ph.D., Yale University

WHY was the summer of 1916 hot and damp in the central and eastern United States? Why was that of 1915 cool and extraordinarily wet in the Middle West? Why was there so much snow in New England in the winter of 1915 to 1916? Was the weather abnormal in other parts of the world at the same time; and, if so, do past records show the simultaneous occurrence of similar extremes? Does the study of the weather of the world as a whole offer any possibilities for making seasonal forecasts? To these and other similar questions only tentative answers can now be given. Some well-established correlations between temperature departures in widely separated parts of the earth are summarized in this article; and the author has assembled weather data of recent months, which, in the absence of complete data, can be offered only as possible illustrations of these correlations.

As these correlations deal with departures from the average, a summary of the normal distribution of pressure may not be out of place here. The intense heating of the air in the equatorial regions leads to a poleward flow of air in the upper levels. On account of deflection, these winds form great whirls, the centrifugal force of which reduces the atmospheric pressure at the earth's surface in the higher latitudes and piles up the air in high pressure "belts" in the sub-tropics. This would-be orderly arrangement is greatly disturbed in winter by the coldness of the continents and the relative warmth of the oceans, which favor the formation of great high-pressure areas on the land and of low-pressure areas over the water. Thus the sub-polar low pressures are still further reduced over the ocean and more than neutralized over the continents, while the sub-tropical high pressures are increased where there is land and somewhat lowered over the water. In summer, the oceanic sub-tropical "highs" are strengthened, the sub-polar "lows" are weakened; and low-pressure areas develop over the heated continents.

It is evident from the foregoing that the changing temperature relations between land and water strongly influence atmospheric circulation, and, furthermore, that winter temperatures in places far apart may very together in the same or in opposite directions. Such is markedly the case in the North Atlantic region, where the connections depend largely on the temperature distribution of the ocean surface waters. There, the Iceland cyclone is intensified[1] when the water in the vicinity is warmer than usual and weakened or even replaced by an anticyclone when it is colder.[2] When the pressure at one place is reduced, it must rise correspondingly elsewhere. Thus it is not surprising that the pressure over the Azores is higher than normal 70 to 80 per cent of the time that the pressure of the Iceland cyclone is lower than normal.[3] A similar relation seems to exist between the Aleutian low-pressure area and the North Pacific sub-tropical high-pressure area, the center of which is near the Hawaiian Islands. Furthermore, pressure changes in the continental anticyclones of Eurasia, North America, and Greenland, and in the Aleutian and Iceland cyclones, seem to be of opposite sign.

Not only may warm water intensify the Iceland cyclone and, in turn, the surrounding anticyclones, but also water temperatures below normal in the vicinity of the high-pressure belt tend to raise the pressure locally and so to shift the Azores center,[4] or perhaps to develop a separate one, as over Bermuda.[5] Conversely, local warm water tends to lower the pressure. The water temperatures affect the pressure distribution; the pressure distribution controls the winds and, so, the weather; and, in turn, the winds through ocean currents and surface drift bring about a rearrangement of water temperatures. As western European and eastern North American are influenced in common by the North Atlantic air circulation, the weather on the opposite sides and in different parts of the same side should not vary independently.

Professor Hildebrandsson states[6] that, in winter, the weather over part of the ocean lying between Iceland and Norway agrees with that of the north of Europe, but is in opposition to the weather in the sub-tropical region, the Azores, and the Mediterranean. The same contrast between the north ahd south is said to occur in North America, but inversely to the relation in Europe; so that if the winter is cold in the north of Europe, it is cold in Mexico and the United States, but mild in the south of Europe and in the north of North America.[7] These relations, however, are often disturbed by external causes of a superior order, such as the varying heat of the sun.[8] Correlations are usually more evident in winter, when local weather is more under the influence of the atmospheric circulation than in summer, when direct solar control usually dominates.

Let us consider these correlations in detail. In the eastern United States the type of winter weather, marine[9], or continental,[10] is deterimned largely by the presence or absence, respectively, of the Bermuda "high." The cause of the Bermuda "high" seems to be a cold water surface,[11] which may depend on the temperature and strength of the Labrador Current.[12] The cold water and ice set in motion one winter by a strong Iceland cyclone may serve to strengthen the Bermuda anticyclone and to weaken the Iceland "low" in the next winter. When the Iceland cyclone is strong, northwestern Europe is warmed by strong southwest winds, and eastern North America is cooled by the strong northwest winds of the other side. On the other hand, when the Iceland cyclone is weak, the weather on both sides tends to become normal for the latitude: which means a cold winter in northwestern Europe and a warm one in northeastern North America. Thus arise the alternating cold and warm winters in opposition on the two sides of the Atlantic, which may continue uninterrupted for a decade.[13]

Europe and eastern North America, on the contrary may be cold at the same time, as in March, 1916. Such is the case when the Iceland "low" is displaced south and extended west, and when many anticyclones move on the northern track across the eastern United States. March, 1915, was similar to March, 1916, in the first particular but not in the second.[14] The possible chains of cause and effect may be as follows: (1) intense Iceland cyclone and Azores anticyclone[15]—strengthened trade winds—strong Equatorial Current—warm Gulf Stream in the following winter;[16] (2) strong Iceland cyclone with high northerly winds on the west side[17]—strong Labrador Current with much ice—cold water in the northern part of the ocean.[17]

Also, coincident warm weather may occur in northwestern Europe and eastern North America, as under the conditions prevailing in January, 1915 and 1916. In January, 1916, the pressure was much above normal in a belt extending at least from southern Europe across the Atlantic through the southeastern United States to Alaska. The pressure of the Iceland cyclone was about normal, but the soutwest winds were strong because of the intensified "high" on the south. In the Pacific, the Aleutian "low" seems to have been pushed south, for the pressures were below normal in the United States west of the Rockies and at Honolulu. These pressure conditions produced intense cold in central North America and mild weather in the East;[18] while England experienced the warmest January on record.[19] This strengthening of the "high" without a lowering of pressure in the "lows" may have been in response to excessive overflow of air from the tropics.[20] In fact, cold weather in central North America comes with a southward displacement of the Aleutian "low," a movement not wholly unrelated to a similar one on the part of the Iceland center, as seems to be indicated in February and November, 1915, January and March have been particularly patent, the important pressure reversals between the 19th and 20th being simultaneous in the Azores, the Aleutians, and Hawaii.[21]

Temperatures in the southern hemisphere seem to be no less closely correlated. Mossman[22] has found that there is opposition between the Weddell and Ross Seas in pressure and wind at all seasons and opposition in temperature in winter. Furthermore, there seem to be seasonal contrasts between the Ross Sea, on the one hand, and southern South America, parts of West

DEPARTURES IN TEMPERATURE, RAINFALL, AND CONTROLLING CENTERS OF ACTION

		EUROPE						NORTH AMERICA								
		London		Iceland cyclone		Azores anticyclone		Bermuda		St. Johns, N. F.			Washington, D. C.		Pierre, S. D.		
		T	R	Pr	Po	Pr	Po	Pr	T	Pr	T	R	T	R	Pr	T	R
1915	Nov....	+0.9	+	−1	0	+2	W	+3	−0.4	−3	0.1	+	+0.2	—	+1	+5.4	—
	Dec....	+1.5	+	−8	SE	+4	0	+1	+1.3	+2	−2.2	—	−1.8	+	+6	−2.8	—
	Jan....	+0.7	+	−2	SE	+4	W	+2	+0.8	+2	+1.2	—	+1.5	+	−2	+1.0	+
	Feb....	+0.4	+	−4	SE	+4	0	−1	+0.2	+5	+1.4	0	+2.4	0	+1	+3.6	+
	Mar....	+0.2	—	−10	far SW	−3	far NE	−6	−2.5	−22	+2.8	—	−1.9	—	+9	−4.3	—
	April...	0.0	—	−3	NE	+8	NE	−2	−0.7	+3	+2.4	—	+3.5	—	0	+4.6	+
1915	Nov....	−2.4	0	+3	E	0	N	−1	−1.2	−6	+2.2	+	+0.7	—	−3	+3.7	+
	Dec....	+2.3	+	−3	SE	+	E	−1	−1.7	−7	+2.3	0	−0.5	—	−1	+3.2	—
	Jan....	+4.0	—	−1	E	+4	E	+7	−1.1	−5	−1.1	—	+3.8	—	+4	−6.4	0
	Feb....	0.0	+	0	N	+10	N	+2	+2.6	0	−0.5	+	−0.2	0	+6	+1.3	—
	Mar....	−1.3	+		far SW	.....		.....		−8	−1.3	0	−2.4	—	−2	2.8	—
	April...	+0.6	—	.....		.....		−2	+0.1	−2	+1.4	—	+0.2	0	+3	−1.1	—
	May....	+1.8	0	.....		.....		+1	−0.9	−8	+0.8	+	+1.4	—	−2	−1.3	+
	June....	−2.4	0	.....		.....		−1	−2.0	+3	+0.9	—	−1.7	+	+1	−3.0	—
	July....	−0.8	—	.....		.....		+1		.....			+0.7	0	−1	+3	
	Aug....	.....		.....		.....		+1		.....			+0.9	—	+1	−0.6	+

Abbreviations:

T: departure of monthly mean temperature from the normal; C. degrees.

R: departure of total rainfall of the month from normal; 0 indicates less than 10 per cent.

Pr: departure of month's mean pressure from normal; units millibars (or kilobars), 1 +0.03 inches of mercury approximately.

Po: position of the center of lowest or highest pressure relative to the normal.

Sources: (Iceland and Azores pressures haveing been derived from may comparisons, or inferred, are uncertain.)

November, 1914, to April, 1915—
Charts IX, *Monthly Weather Rev.*, Vols. 43-44, Nov., 1915, to April, 1916; and tables, *ibid.*, Vols. 42-43, Nov.-Apr.1915.

November, 1915, to January, 1916—
Monthly pressure maps of Europe in *Das Wetter*, Vols. 32 and 33, Nov., 1915, to Jan., 1916.
Maps of mean monthly pressure, Bartholomew's Physical Atlas, Part III, Pl. 12.
Monthly Weather Rev., tables, November, 1915, to January, 1916.

February to June, 1916—
Monthly Weather Rev., tables, February to June, 1916.
Symon's Meteorol. Mag., Vol. 51, "Weather of the Month."
London data from *Symon's Meterol. Mag.*, North American data from *Monthly Weather Rev.* July and August, 1916. *Symon's Meteorol. Mag.*, Vol. 51, "Weather of the Month."
Washington daily weather maps of U. S. Weather Bureau.

*The *Geographical Review*.

[1]As in December, 1914, January, February, December, 1915, and January, 1916. These and other months mentioned in the footnotes are suggested as possible illustrations, water temperatures and full pressure data not being available now. See the table.

[2]November, 1915, March, 1916.

[3]J. von Hann: Lehrbuch der Meteorologie, Leipzig, 1915, pp. 637 to 644, gives a good summary of European and other correlations.

[4]To the east—March, December, 1915, January, 1916; to the west—November, 1914.

[5]January, February, April, 1915, January, 1916.

[6]Summary in *Nature*, Vol. 97, 1916, p. 228.

[7]Such was more or less the case in March, 1915.

[8]January, 1916, may have been an illustration of this condition.

[9]January, February, April, 1915, January, 1916.

[10]December, 1914, March, 1915, 1916.

[11]November, 1914, January, 1916, summer, 1916. Southerly winds off the ocean in midsummer bring sultry hot weather to the North Atlantic states.

[12]W. J. Humphreys: Why Some Winters Are Warm and Others Cold in the Eastern United States, *Monthly Weather Rev.*, Vol. 42, 1914, pp. 672-675, 35 charts.

[13]Cf. Hann: *op. cit.*, pp. 639, 640, and C. Abbe, Jr.: Washington and Paris Winters, Table 2, *Monthly Weather Rev.*, Vol. 42, 1914, p. 627 (Opposition Washington-Northern Europe, 1874 to 1883).

[14]See A. J. Henry: Control of March Weather by Pressure Distr bution, p. 139, and Charts II, IV, and IX, *Monthly Weather Rev.*, Vol. 44, March, 1916.

[15]Winter 1914-15.

[16]M. W. Campbell Hepworth: The Gulf Stream. *Nature*, Vol. 93, 1914, pp. 441-443. See also footnote 33.

[17]Winter 1915-16.

[18]Temperature departures: at Harve, Mont.,—15 C.; in the East, ½3 to 5 C. from normal January temperature (*Monthly Weather Rev.* Vol. 44, 1916, p. 48, and Chart IV). For remarks on Canadian conditions see *Nature*, Vol. 97, 1916, pp. 470-471.

[19]London was warmer by 1 C. than any January at least since 1858 (*Symons's Meterol. Mag.*, Vol. 51, 1916, p. 7).

[20]See *Monthly Weather Rev.*, Vol. 44, 1916, 0. 78; *Bull. Amer. Georg. Soc.*, Vol. 47, 1915, p. 963. The fact that January, 1916, was abnormally wet at Sta. Lucia and, to some extent, at Curllioma in the Andes of Peru may have some significance here, as indicative, perhaps, of abnormal doldrum rains.

[21]*Monthly Weather Rev.*, Vol. 44, 1916, p. 210. Before the 20th pressures were below normal in eastern and southern Alaska and above normal at Honolulu and the Azores; after the 19th, pressures were above normal in Alaska (eastern and southern) and below normal at Honolulu and the Azores.

[22]Review, *Georg. Rev.*, Vol. 1, 1916, .p 323.

Australia, and New Zealand, on the other.[32] The winter of 1915 may perhaps be taken as an illustration. In Australia, the winter and greater part of the year were remarkably warm, with prevailing moist, north winds.[34] The Argentine winter was very cold, and the ice conditions in the Weddell Sea were severe.[35] South Africa was apparently colder than usual.[36]

In addition to correlations within a hemisphere there are three types of connection between centers of action on opposite sides of the equator. One is direct, where winds flow from one to another, so that any variation in either may be felt in the other hemisphere On this basis, forecasts are made of the character of the southwest-monsoon rainfall in India,[37] and of the height of the Nile flood.[38] A second type of correlation is that of simultaneous expression of a common cause. Thus, when the sun's heat is more intense and produces a lower pressure in the equatorial regions, as at a time of sunspot maximum like the present, the polar pressures may rise and polar weather may then be colder.[39] It is possible that the following weather conditions in the middle of 1915 had such a common origin: warm, damp winter in Australia, warm summer in the southern United States;[40] extraordinary ice conditions reported by Shackleton in the Weddell Sea, cold winter in southern South America; unusual ice in Arctic waters reported by the Danes[41] north of Iceland and by MacMillan's expedition west of Greenland,[42] pressures above normal and temperatures below normal in Canada and Alaska;[43] cool and very wet weather in the central United States.[44] It is suggestive, also, that in the central United States the three very wet Mays and Junes occurring in the last thirty-five years came in 1892, 1903, and 1915—all during sunspot maxima (the average period from one sunspot maximum to another is 11.4 years).

A third type of correlation is the delayed, indirect effect which operates through the medium of ocean currents.[45] The Gulf Stream, for instance, is supported by the Equatorial Current, the strength and temperature of which depends on the trade winds on both sides of the equator. Although this control of the weather of one period over that of a later one has been mentioned, an immediate, though speculative, example may be added here. It seems possible that the character of the summer of 1916 was connected in some degree with the weather of the summer of 1915. The warmtb of the Gulf region communicated slowly by the Gulf Stream to the northeastern Atlantic may have had some part in producing the intensity of the Iceland cyclone in December, 1915. This strength of the Iceland cyclone probably set in motion southwards the accumulated ice in Greenland waters, the first effect of which was to raise the pressure about Iceland and so to give England the weather which culminated in the extraordinarily wet and snowy March (see table). In April, the reports of pack-ice off Newfoundland, with the establishment of a more or less permanent "high" east of New England, indicated, perhaps, further progress of the ice. In the northeastern United States, in April, May, and June, 1916, the resulting on-shore winds off the cool ocean brought cool wet weather; but in July, the damp ocean winds from the south were warm. To the stagnant anticyclone in the east, which at once made gentle winds and prevented rapid movement of cyclones across the United States, may be ascribed, in part at least, the July hot spell of the Middle West. It seems clear that the weather near the sources of ocean currents and the strength of the driving winds have effects thousands of miles away and months later.[34]

[32] See also R. C. Mossman: Southern Hemisphere Seasonal Correlations, *Symon's Meteorol. Mag.*, Vols. 48 and 49, 1913 and 1914.

[33] *Symons's Meteorol. Mag.*, Vol. 51, 1916, pp. 4-6; and *Nature*, Vol. 97, 1916, p. 471.

[34] *Georg. Rev.*, Vol. 2, 1916, pp. 54-57.

[35] Temperatures at Cape Town and Johannesburg from *Symons's Meteorol. Mag.* were compared with those shown in Bartholomew's Physical Atlas, Part III, Pl. 10, allowance being made for the sea-level "reduction" of the latter.

[36] Summary in *Nature*, Vol. 96, 1916, p. 657; extensive review, *Quart. Journ. Roy. Meteorol. Soc.*, Vol. 42, 1916, pp. 129-132. The forecast for 1916 summarized in *Nature*, Vol. 97, 1916, p. 490.

[37] *Scientific American*, Vol. 110, 1914, p. 392.

[38] Although Blanford (see Hann: *op. cit.*, p. 641) finds correlation of low tropical pressures and high polar pressures, with sunspot maxima, the recent investigations of Dr. G. T. Walker (review, *Bull. Amer. Georg. Soc.*, Vol. 47, 1915, p. 963) question such a relation.

[39] See discussions of "The Weather of the Month," "Forecast and Warnings," charts and tables in *Monthly Weather Rev.*, Vol. 43, 1915, May to August inclusive.

[40] *Nature*, Vol. 97, 1916, p. 248.

[41] *Georg. Rev.*, Vol. 2, 1916, p. 65.

[42] "Meteorological Aspects of Oceanography" is the title of an article by Hans Pettersson in the *Monthly Weather Rev.*, Vol. 44, 1916, pp. 338-341, which deals with this subject, particularly in relation to seasonal forecasts.

[43] A successful prediction of the temperature over northwestern Europe last winter was made by P. H. Gallô, who based his forecast on the close positive correlation between the strength of the North Atlantic trade winds from May to October and the temperature over northwestern Europe the following December to February. See note in *Nature*, Vol. 97, 1916, p. 526.

The weather in widely separated parts of the earth is correlated because of the extensive control of the large belts and centers of atmospheric action. In the North Atlantic, for example, the strength, positions, and relations of the Iceland cyclone and of the Azores anticyclone dominate the weather of the adjacent region; and the resulting movements of surface waters of different temperatures change these centers of action. Similar relations seem to exist elsewhere. These are subsequent, however, to changes in the sun's radiation, which produce immediate, world-wide pressure alterations. Any possibilities for widespread seasonal forecasts must rest, therefore, first on an ability to forecast solar changes and, second, on a knowledge of the immediate and subsequent atmospheric effects of such variations.

Harnessing a Volcano to a 15,000-Horse-Power Electric-Power House*

THE idea of utilizing volcanic heat to drive an important electric power-house of 15,000 horse-power might have been considered utopian in ordinary conditions. It has, however, become a reality—and a successful one—in these hard times, when the price of coal has reached in Italy the incredible figures of £8 to £9 a ton in the harbors and £9 to £10 in inland towns—plus the cost of carriage from the stations to the works!

The installation had this origin: As is well known, in Central Tuscany, near Volterra, there are numerous cracks in the ground, from which powerful jets of very hot steam spout high in the air with great violence and constancy, bringing up boric acid, which is very valuable, and other mineral substances of less importance. These powerful jets of superheated steam are called *Soffioni*—the "blowers"—and have been utilized for many years in the production of boric acid and borax, and occasionally for warming the houses in the nearby village of Larderello. The larger proportion of the steam, however, is lost, having no local application, and with it is lost its very valuable heat.

Prince Ginori-Conti, the intelligent and active president of the "Società Boracifera di Larderello," was the first, in 1903, to try to utilize this superheated steam for the production of motive power. At first he applied a strong jet to a small rotary motor, then to a very modest reciprocating steam engine connected to a dynamo, which generated sufficient current to light part of the borax works. In the meantime he tried to get a more ample supply of steam by boring holes in the ground, lined with iron pipes, driven down to the very source of the steam, which is under a hard stratum of rock about 300 to 500 feet below the surface. These bore-holes vary from 12 to 20 inches in diameter, and give forth steam with a pressure from 2 to 3, and exceptionally up to 5, atmospheres, and at temperatures varying from 150 deg. Cent. to 190 deg. Cent. For several years these jets have not diminished in their capacity, nor does a new boring seem to interfere with the preceding ones, provided the distance from one to another is not less than 50 feet.

Experiments made very accurately demonstrate that each bore can provide steam at a temperature of at least 150 deg. Cent., and at the rate of from 15,000 to 25,000 kilogrammes per hour, that is, practically, from about 1,000 to 2,000 theoretical horse-power per hour. Thus near Larderello there is the possibility of developing motive power to the extent of thousands and thousands of horse-power. Encouraged by these results, Prince Ginori-Conti, in 1906, applied the steam to an ordinary steam engine of about 40 horse-power. The experience of several years has shown that this arrangement works well so far as the mechanical power of the steam is concerned, but that the borax salts and the gases mixed with the steam—especially sulphuretted hydrogen and traces of sulphuric acid—have a corrosive action on the iron parts of the engine and are the cause of frequent repairs.

This difficulty was avoided by applying the superheated steam, not directly in the engine, but to a boiler; that is, by applying it instead of fuel to an ordinary multitubular boiler, in which steam was produced at a pressure of two atmospheres, then passed through a superheater, and afterward used for driving a 300-horse-power condensing steam turbine, directly connected with a tri-phase electric generator, which supplies the works and the villages around Larderello. This installation had been at work quite successfully for several months when the war broke out. Then, coal becoming very scarce, and prices rising up to prohibitive limits, the possibility of using on a large scale this natural steam became very important.

Prince Ginori-Conti considered it his duty to carry out this trial on a large scale, availing himself of his long and successful experiments. Acting on the advice of the Tosi Works, of Legnano, specialists in steam turbines and alternating electric generators, he ordered three groups of condensing turbo-electric engines, each of 3,000 kilowatts, working with superheated steam at 1½ atmospheres, generated in specially-constructed multitubular boilers, the latter arranged vertically and with aluminium tubes, both for better utilization of the heat and better resistance to the corrosive action of the natural steam from the *soffioni*. This steam, it is worth while to repeat, is used instead of combustible; it loses part of its heat in the boiler, reducing its temperature from 180 deg. Cent. to about 120 deg. Cent., and is then utilized for the borax industries.

The steam thus generated in the boilers and used for the turbines is ordinary water steam, which on its way to the turbine passes along aluminium pipes heated outside by a current of superheated natural steam, at 180 deg. Cent., and thus gets in its turn superheated to about 150 deg. Cent. After passing through the turbine this steam is discharged into a surface condenser, the circulating water of which is in its turn cooled in an ordinary cooling tower. The condensed steam from the turbines is, of course, pumped back into the boilers, and thus no natural steam ever comes in contact with the turbine; by this arrangement corrosion is completely avoided. This was the real difficulty to be overcome.

The tri-phase electric current is generated at 4,500 volts and 50 periods per second, raised up through an oil transformer to 36,000 volts, and sent along aerial conductors to Florence, Leghorn, Volterra, Grosseto and many smaller towns of Tuscany, to be principally used as motive power for munition works during daytime and partly for lighting purposes at night.

One of the 3,000-kilowatt units has been at work since January, 1916, the second since April, and the third has just been started. So far, the first two groups have worked quite successfully and have been a great boon to the industries of Tuscany, greatly crippled by the scarcity and high price of coal. This very successful harnessing of volcanic heat to an electric power-house can be increased practically to hundreds of thousands of horse-power, as the region of the *soffioni* extends for many square miles around Larderello.

Also in the "Campi Flegrel," near Naples, the ground in some parts and at depths of about 100 feet being almost red-hot, some similar utilization of volcanic heat is already being contemplated. The Larderello power-house is, however, the first, and a very important and successful example of what has been done with volcanic heat in Italy. The results are well worthy of careful consideration, and Prince Ginori-Conti, who has financed the undertaking and steadily brought his experiments to a brilliant result, deserves great praise.

*Engineering.

French Legislation Upon Hydraulic Plants

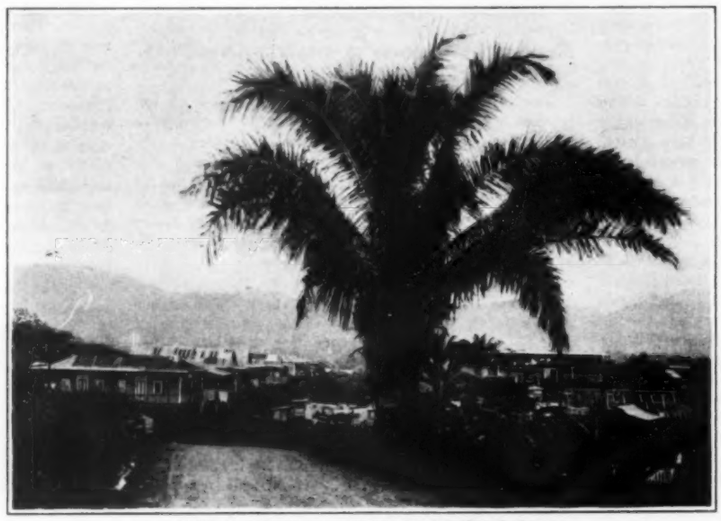
THE French Parliament is engaged in discussing a bill relative to hydraulic power in that country, and owing to the increasing importance of this question the necessity of proper legislation is recognized at present. But as the matter is of a very complex character, this is by no means easy to carry out. The promoters of the present bill bring out in the first place the importance of hydraulic resources in the country as well as the present status of the industry and the outlook for the future. Although hydraulic power cannot replace coal, it will at least prove an efficient aid. No less than $110,000,000 are now interested in this industry, and there is great hope of future activity by the adoption of improved power line systems and a more equitable distribution for light, power, traction, electro-chemistry and electrometallurgy. According to the present project, hydraulic energy forms part of the national resources and no one shall be allowed to exploit it without state authorization. There will be two main classes of hydraulic plants, first, authorized plants, and second, conceded plants. The former comprise small plants under 500 kilowatts of a non-commercial nature, while all other plants must be subject to a concession. In this latter class there are two categories, first, up to 10,000 kilowatts and second, above this figure, the first being conceded by a simple decree from the Public Works department; but for the second category, that is the high power plants, a more formal decree from the state will be necessary. State participation in large hydraulic enterprises is also provided for, and the state receives a stipulated part of the capital stock and is paid at least one-fourth the profits after deduction of six per cent upon the capital, with some other reserves. For the high power plants just mentioned, the state must be represented in the Board of Directors by two officials chosen among the state engineers.

The Cohune Palm

A Central American Tree, the Nuts of Which Produce a Valuable Oil

By C. D. Mell

ATTENTION has frequently been called to the cohune palm (*Attalea cohune*) as a source of useful oil. Those who have traveled in Central America are familiar with this ever-present palm, the nuts of which produce the bulk of the oil now used by the inhabitants for lighting purposes. It has long been known that the nuts of this useful tree produce an oil of considerable value for industrial purposes. Recent added interest and importance is lent to the feasibility of establishing a palm-kernel oil industry in Central America on account of the constantly increasing world demand for oil due to war conditions. The cohune palm nuts are the subject of numerous inquiries and, as the information published regarding them is not available, it may be of interest to a number of readers to note the following facts relative to this valuable tropical forest product.



Cohune palm tree, growing in the Canal Zone

The most familiar name for this palm is cohune, sometimes written cohoun or cokune. The English-speaking people in the region where this tree grows refer to it occasionally as the Prince of Wales palm. The people of Guatemala call it the manacca, and in other parts of Central America it is known as corozo. The tree resembles in a general way the cocoanut palm, but it is not so tall and the trunk is considerably thicker and shorter. It has a crown of immense leaves which are said to attain a length of from thirty to forty feet and in rare instances as long as sixty feet. These leaves do not droop as in other long-leaved palms, but they spread very gracefully by the slight bending of the long stout midribs, which renders the cohune palm one of the most magnificent trees of its kind, and, therefore, is used in many places for shade and ornamental purposes.

The geographical distribution of the cohune palm extends from southern Mexico southward to Colombia, where it begins to grade into several other species of the genus *Attalea*. It attains its best development in British Honduras, Guatemala and Spanish Honduras. In the latter country, which has an area of approximately 37,500 square miles, it has been estimated that fully two fifths is covered with cohune forests. In Spanish Honduras and Guatemala the palm is confined largely to the sandy or well-drained uplands known as cohune ridges, where this palm, in different stages of its growth, forms probably twenty, and in some cases thirty per cent of the vegetation. In British Honduras it occurs rather uniformly throughout the colony and is found even to some extent in the hardwood forests composed of cedar, mahogany, fustic, sapodilla, etc. It appears, however, that the cohune grows best on abandoned cleared areas.

While every part of the cohune palm is utilized locally to a greater or less extent the most valuable product is the fruit or nut which is borne in large branches often weighing over two hundred pounds. They hang down from near the base of the leaves like huge clusters of grapes, often from two to three feet long. The fruit has a tough outer fibrous layer, technically known as the pericarp, that is about one half inch thick. Although this layer contains considerable fat, it is not likely to be of value under present conditions for making palm nut oil. After the pericarp is removed there remains the so-called "nut," which measures from two to three inches in length and about one and one half inches in diameter. It has a hard woody shell or endocarp of about three tenths of an inch in thickness that is extremely difficult to crack. Within the endocarp is embedded the kernel which has the appearance of a large nutmeg, and contains from 40 to 60 per cent of valuable oil useful for many purposes. A number of attempts have been made to establish an industry in connection with the extraction of the oil from the kernels, but so far with no great success. The difficulty has been in connection with the breaking of the hard shell or endocarp surrounding the kernel. A good many different machines have been devised for cracking these nuts, but they all proved failures with the exception of one or two kinds which have been perfected in this country and are now being used successfully in British Honduras. It is believed that the problem of cracking the nuts has now been solved and that as soon as the war is over and a number of the cracking machines can be procured from the factories that are now working overtime on war orders, an industry of considerable proportions will develop in the region where the cohune grows most abundantly.

Showing relative sizes of clusters of the cohune nuts and bananas

Nut produced by the cohune palm

Considering that cohune oil is a marketable product in Europe and America in any quantity at the price of the finest and purest coconut oil, it is a matter of regret that this valuable forest product has not been turned to economic use many years ago. Many thousands of tons of cohune nuts found growing wild in the woods of Central America go to waste annually. It has been conservatively estimated that there are twenty-five cohune palms to the acre in British Honduras. A tree yields 1,000 nuts annually and about 100 nuts are required to yield a quart of oil. At this rate every acre would produce 250 quarts of oil a year, or approximately 275,000 tons of oil in British Honduras. It is believed that Guatemala and Spanish Honduras would each produce a much greater quantity. If this dormant industry in Central America were awakened to full capacity, more than a million tons of oil could be obtained and sold at a price per ton appreciably above that which obtains for coconut oil to which it is superior. There is practically an unlimited demand for a similar oil from West Africa in the European margarin trade where it is preferred to oleo oil and neutral lard as a hardening ingredient. The cohune kernel oil resembles very closely both coconut and African palm kernel oil, but it is generally of somewhat softer consistency.

Indoor Telephotography

THE attention of the photographic public has been drawn to telephoto lenses almost exclusively by means of the wonderful pictures of distant subjects taken at great magnifications, but the fact seems to have been generally overlooked that this type of lens is very useful for photographing quite small objects, either to their natural size, or on a moderately reduced scale. The advantage over an ordinary lens is that the camera is further away from the subject, so that better perspective is obtained, and a small background can be used with the certainty that it will be well out of focus. A fairly long focus is needed, but I have photographed objects, both indoors and out with a small "Adon" (adjustable type) drawn out as far as it would go, and with a camera extension of about twenty-two inches. The subjects were taken actual size on whole-plates. Of course the exposures are rather long, but once the time is found, especially with artificial light, it is easy to standardise the conditions. The best way to focus is to move the camera as a whole to and from the subject while examining the image with a focusing magnifier.

I have used a telephoto lens for details of interior architecture, but there is a large element of luck in that sort of thing. It is only possible to focus after the head has been closely wrapped in the cloth for some time, to get used to the dim image. It is necessary to make sure that the room will be undisturbed during the very long exposures, because the slightest vibration will affect the telephoto image to a great extent.—ASCOT in *The Bristol Journal of Photography*.

A Novel Use of Okra

OKRA, as found in the barrios of Talontalon and Mercedes, Zamboanga, is the Philippine rival of Postum. Here the use of the plant as a vegetable is scarcely known, but it is cultivated rather extensively to provide a substitute drink for coffee.

The seeds of the ripened vegetable are dried and roasted in a covered clay pot to prevent the popping or bursting of the kernels. When a rich brown color has been secured they are ground fine. The odor is strongly suggestive of coffee.

The drink is prepared exactly like coffee, except that the amount of powder used is usually doubled. Sometimes a little ground coffee is mixed with the okra to strengthen its flavor.

The natives of the above-mentioned barrios attribute the introduction of this novel use of okra to an American. —(E. H. H.) in the *Philippine Craftsman*.

The Laundries of the Ancients*

By Henri Rousset

We do not realize, when we use our modern methods of washing linen, that they represent centuries of labor and ingenuity, that they sum up the results of thousands of experiments. For centuries, in lack of convenient processes, people were obliged to use very inconvenient ways of laundering. It is interesting to know how these ancients of whom we are often told—Egyptians of the time of the Pharaohs, old Greeks and Romans—washed their linen. Modern historians are fond of such details which, better than official history, enable us to appreciate the character of a people; and we can find in their works some very good accounts of the state of the laundry art in the old ages. Of course, numerous details are lacking, but the chief features are known. We shall describe them, suppressing purposely all worthless display of erudition.

MATERIALS USED

The launderer of the ancient Egypt could use neither soap nor Javelle water. Before studying his process, we must first know the products he has at his disposal. Those were relatively numerous. Among the natural products known in antiquity and used in the different arts were several having detergent properties, clay, alkali, etc.

Clay and Chalk.—Several mines were exploited to produce the variety of clay used in the cloth industry, to clean and to fill woolen fabrics. The best clay was named cimolia, because found in the Cimolos Island, one of the Cyclads. Other varieties came from Italy (umbrica terra), from Sardinia (sardo), from Samos and Lemnos. They were employed not only for cleaning, but also for sizing woolen fabrics. Some of these products were chalks rather than clays. Tournefort, during his travel in Milo Island, analyzed cimolia which was found to be almost pure carbonate of calcium. The peasants of Cimolos still use this product instead of soap to wash their linen.

Vegetable Powders.—The absorbing vegetable powders still used in some detergent preparations (to remove the greasy stains) were employed by the Romans to clean fabrics. Caelius mentions the lomentum (lima bean or pea flour) as a good cleaning agent, which, however, was more often used for washing the face than to clean the clothes.

Alkalies.—Wood ashes are mentioned in Aristophanes' and Plato's works as products used in washing. The most efficacious solution was prepared from the the ashes of the fig trees and grape vines. Under the name of nitrum, the Roman artisans used also products containing large proportion of carbonate of sodium and potassium. Almost all the nitrum came from Egypt, where there were natural layers, and several mines. Very considerable quantities were consumed, not only to clean, but also to produce glass, dyes, drugs, etc.

The urine was used in Rome to clean clothes; after fermentation the liquid becomes rich in ammonia and can replace a solution of ammonia. This Roman use of urine is very well known, because one of the Latin emperors put a tax on the urine collected in vases placed by the cleaners in different public places. Tradition relates that this emperor replied to his son who was disgusted with seeing the state collect money from such a source, "Money does not smell, my son."

Soap.—The ancients did not know soap. What the Latins called sapo was not a product like our modern soap, but a mixture of grease and wood ashes, containing an excess of unneutralized alkali. This sapo was not a cleaner, but a cosmetic, used to make blond the hair of the Latin brunette.

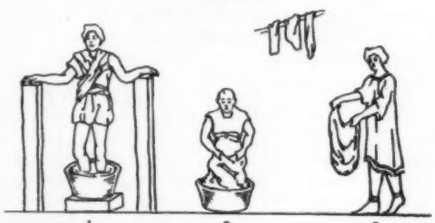
Saponius.—The roots of the saponaria were used in Greece and Latin empires. The plant was known by the name radix lamaria and herba lamaria; but it is presumed that it was not used in the laundry. but only to clean the wool in the grease.

METHODS OF WASHING

Ancient Egypt.—The specialists in the history of old Egyptian daily life seem not to be very well informed about the methods of washing of these times, although good methods were certainly used, because we know they not only washed, but sized the linen. In the Florence Museum is kept a kind of board engraved with parallel small furrows, which was used to produce a special finish upon the pieces of clothes. Erman notes that in the Pharsonic court was a chief washer, a very important officer, and gives the reproduction of an Egyptian picture of the middle empire, with this explanatory note: "We see the washers beating the wet clothes with wooden staves; they sprinkle them holding their arms up high. They hand one end of the folded piece of linen over a post, put a stick through the other end, and wring it with a good deal of force. They then stretch and fold up the linen and finally the chief packs it up in a great bundle." We give herewith the reproduction of the explained picture.

Ancient Greece.—In the ancient Greece the clothes were washed in special basins, built in the river bank or near a spring. Here the pieces were tramped with the feet, to expel the dirt. The best poet of all ages, Homer, told in his Odyssey of a Grecian laundry, operated by the Princess Nausicaa, daughter of the Phaecian king. "Father," the girl said, "would you not order a large carriage, to carry our dirty clothes to the river, in order to enable me to wash them? Seated the first in the council, you must wear clean clothes; and my brothers must have clean clothes, too, to go to the dance." In reality, the girl wished especially to have her own clothes clean, because she hoped to become engaged very soon; but as a princess, she was very "diplomatic." The king father having agreed, Nausicaa and her girl servants went to the river. "There," the poet said, "were cisterns filled all the year with water good for cleaning

Egyptian Method of Washing. 1—Washing; 2—Wringing; 3—Folding



Roman Methods of Washing. 1—Treading; 2—Rinsing; 3—Hanging

Grecian Women at Laundry Work

all soiled articles. The girl plunged the clothes into the deep water and tramped them; afterward they spread them on the rocks of the shore—and the clothes dried under the sun splendor." From the pictures on some ancient vases, we can see that the pieces were wrung by hand, a process which is still used in many countries.

The Homeric process concerns the prehistoric Greece. Later, in the Grecian cities the methods used to wash linen were the same as in Rome. In both places, professional cleaners applied them. We know that in Athens there were professional launderers, the trade being followed by both men and women. They charged very low prices. Aristophanes mentions in one of his comedies that it costs only ten cents to clean a coat. It is true that the Grecian clothes were, as well known, of very simple form. A piece of fabric, just draped on the body, sometimes constituted a whole suit.

Ancient Rome.—In Rome, the washing of clothes was never—at least in historical times—done at home, except in the houses of some patricians, who were rich enough to maintain a professional shop for the use of their family, servants and perhaps "clients." All the clothes being made of wool, the cleaning of worn pieces was done by the same method as the cleaning and sizing of fabrics just from the loom. The fullones who did the work were organized in powerful corporations, owning important shops, with large tanks and pipe systems to furnish water, etc. They washed by treading the pieces placed in baths of water and clay or chalk, or fermented urine, etc. After rinsing, the white articles were exposed to the action of sulphurous anhydride, produced by burning sulphur in the air of a small closed chamber, made with sticks of wicker, assembled in the form of a big bell. The clothes covered the sticks and the sulphur burned in the center of the bell. Finally, the fabrics were sized by scratching regularly their surface with special kind of thistle and by rubbing with certain kinds of chalk. At last, the pieces, lightly dampened with water blown in small drops from the mouth, were pressed with a special apparatus.

Pliny says that in the old period of the ancient Rome, two "censors" proposed a law, which was adopted by the people, to regulate the trade of the "fullones." The official process, which was made compulsory to avoid any dishonest competition is described as follows: (1) Washing with terra sarda and water; (2) fumigating white articles with burning sulphur; (3) rubbing with terra crimolia for colored garments, terra saxum for white pieces. Afterwards the law became obsolete and the fullones had all liberty of managing the cleaning as they wished to. In general, they always chiefly operated by treading the pieces placed in small basins, as we can see from the contemporary fresco, discovered in a Pompeiian home, of which some pictures are reproduced here.

We can see that the "fullones" were rather more cleaners than launderers. They worked so well that sometimes it was impossible to distinguish an old article from a new one. However, they charged very reasonably, and often the Roman customers paid a fixed amount by the year to the nearest cleaner's shop to have all necessary cleansing done for them.

*From The National Laundry Journal.

Origin and Culture of the Navel Orange

New light has been thrown upon the origin of the navel orange by study of the conditions surrounding its culture at Bahia, Brazil. Interesting facts were gathered by specialists of the United States Department of Agriculture who were in search of new plants in the South American country. All the evidence points to the fact that the variety of navel orange now so largely grown in the United States first came into existence at Cabulla, a suburb of Bahia, early in the nineteenth century, as a sport from the Selecta orange. The latter variety is still grown extensively near Bahia and in other parts of Brazil, and some of the trees show a marked tendency at times to produce fruit with well-developed navels. Such fruit, however, is not seedless, though the number of seeds is relatively small. The navel variety has almost entirely supplanted the parent variety about Bahia, where it has been known for more than 100 years. In the vicinity of Rio de Janeiro but few trees of the seedless variety are grown.

It was from a plantation near Bahia, so far as can be determined, that the budded trees were obtained through which the navel orange wood was introduced into the United States. Several were shipped to the United States Department of Agriculture. Trees were grown in the department greenhouses, and others propagated from them were distributed to California and Florida. The variety proved to be unsuited to Florida conditions, but in California is it very productive and highly valued. Almost the entire present planting of the variety in that State can be traced directly back to two of the trees sent there by the Department of Agriculture in 1873.

The navel orange in Brazil, unlike its descendant in California, grows under warm conditions. Seedlings of the bitter or sour orange (*Citrus aurantium*) are employed almost exclusively as stocks, and the navel orange wood is propagated on them by shield budding in essentially the same way that buds are propagated in the United States.

The navel orange as it occurs near Bahia is large, varying from 3½ to 4 inches in diameter, is yellow-green in color, and extremely juicy and sweet. Comparative studies made by the Department of Agriculture show that the Brazilian fruits have a considerably lower percentage of peel than the California fruits and somewhat less fibrous matter or "rag." The California orange, however, has a much larger percentage of both citric acid and sugar.

Bud wood from a number of the most promising strains of the Bahia navel orange trees was brought to the United States by the department's plant explorers and is being tested in California and Florida. It is pointed out by the department that because of the important effect of climate on the size and character of the fruit it is impossible to determine in advance whether strains which appear desirable in Bahia will retain their characteristics in the United States. This can be decided only by the tests now under way.

Bulletin 445, issued by the Department of Agriculture, gives the details of the investigations of this subject that have been conducted.—*U. S. Commerce Report.*

Lag in U. S. Naval Radio Time Signals

The U. S. Naval Observatory has determined the lag of the Arlington signal to be about two hundredths of a second (.02) and that of the Key West signal to be about twenty-seven hundredths of a second (.27), this lag being due to the various relays in the telegraph lines over which the time signal passes from the Naval Observatory. The error of the time signal is generally less than one-tenth of a second (.1).

Importance of the Relation of Solid Surfaces and Liquid Films in Some Types of Engineering Construction*

By Clifford Richardson

THE importance of surface phenomena as they relate to the stability of earth fills, embankments in relation to water, and more especially in the construction of asphalt pavements and highway surfaces, has only been adequately recognized during the past few years, although attention was called to some features connected therewith as long ago as 1905 by the writer, in "The Modern Asphalt Pavement." It was there demonstrated that the finer the mineral aggregate in a sheet asphalt pavement the greater the surface area of the particles which is to be coated with bitumen and the more satisfactory the pavement.

The great advance that has been made in the last ten years in our comprehension of the relation of solid surfaces and films of liquids in contact therewith, and especially of the relation of solids in a colloidal state to liquids with which they may be associated, makes it possible to apply the information which has been developed to an interpretation of the phenomena which are connected with the rational construction of bituminous road surfaces.

Great energy is displayed by the contact of solid surfaces with liquid films. This is known as surface energy. Where a solid is uniformly dispersed through a liquid this is known as a physical system. In such a system energy is developed and this energy is proportional to the area of surface displayed by the solid and to the character of the liquid in which it is dispersed. The relation of the extent of surface displayed by the solid and the liquid covering it, plays an important part in the surface energy developed in any system consisting of subdivided mineral matter and bitumen in a more or less liquid form. It is of great interest in reaching a rational interpretation of the relations of these materials in the construction of asphalt pavements and roads.

In 1905 it was shown by the writer, in the book which has been mentioned, that the increased extent of surface offered by a fine aggregate as compared with the coarser material, was enormous. One gram of sand, consisting of grains of uniform size which would just pass a 10 mesh sieve and have a diameter of about 2 millimeters would consist of 212 particles having a surface area of 15 square centimeters. If the same weight of material were reduced to a size which would just pass a 200 mesh sieve having openings .08 mm. in diameter the number of particles would be increased to nearly one and a half million and the surface area would be 283 sq. cm. Proceeding still further and reducing the particles to a size of .002,5 mm. they would number over forty-six billion and the surface area would be more than 9,000 square centimeters. The relation of the surface area of the material as a solid mass to that of the surface of the same material when subdivided, is known as specific surface.

As stated by Ostwald, "Surface energy, as usually discussed, is made up of two components: *a capacity factor* as measured by the absolute surface, and an *intensity factor* as measured by surface tension. The latter type of surface energy endeavors to *decrease* the surface of a system if free energy is available."

In a sheet asphalt paving mixture the capacity factor is measured by the degree of fineness of the mineral aggregate, and the intensity factor by that of the character, that is to say, the surface tension, of the bitumen which is in use as a cementing material.

In the case of very fine aggregates the increase in the surface area, that is to say, the specific surface, is, as has been demonstrated, enormous, as compared to that of a coarse one and would necessarily call for a larger amount of bitumen to cover it. This fact has an important bearing on asphalt surface mixtures, as prepared from different sands and with different amounts of filler. For example, the mineral aggregate of a coarse New York mixture laid in 1895 was found to have a surface area of about 44 square feet in one pound of material, whereas in a finer one of 1898 this was increased to over 60 square feet. The former was an unsatisfactory, the latter a very satisfactory pavement. At that time attention was called to the fact that the more extended area of the finer aggregate would require a larger percentage of asphalt than the coarser and was desirable on that account.

No further explanations or conclusions as to the nature of the relations involved were then drawn. With the further study, which has been so widely carried on in the last ten years, on the relation of surfaces and films and of the characteristics exhibited by matter in a highly dispersed or colloidal state, we are to-day in a position to comprehend more fully and explain why this extended surface is a matter of importance in the construction of a satisfactory pavement, and why accepted methods of procedure, which have, hitherto, been founded more or less on an empirical basis alone and not upon certain definite physical laws associated therewith, have been successful. Surface phenomena are now recognized as being of great importance. For a thorough comprehension of the subject, reference must be made to the literature which is available.[1]

Investigations in connection with the relation of the surfaces of mineral aggregates of the type employed in the construction of asphalt pavements and of films of bitumen which serve to cement them together and in other engineering problems as well, have proved of interest not only as explaining the reasons for the successful results obtained in the construction of pavements of the type mentioned, as developed empirically during the last twenty years, but also, carrying these principles much further, in developing the possibility of producing other structural materials containing large percentages of mineral matter in a colloidal state, which are of value as presenting unusual physical characteristics and availability for particular uses.

It was empirically shown as long ago as 1894 to 1896 by the study of successful surfaces that a satisfactory sheet asphalt pavement was one which contained, as part of the aggregate with which the bitumen is combined, a considerable percentage of filler, that is to say, of extremely fine mineral matter. This was attributed to the large extent of surface which such an aggregate offered to which bitumen might adhere, and in this respect was a correct inference. At that time, however, the relation of surfaces and films and the principles of the chemistry of matter in a colloidal state had not been made clear, while to-day this subject has been more thoroughly elaborated and affords a means for the rational interpretation and explanation of the relation of surfaces and films, as applied to combinations of a mineral aggregate and bitumen, and of the enormous energy developed by the extensive surface presented by solid matter in the colloidal state. This now makes it possible to carry out work of this description on a scientific and rational basis.

One cannot properly speak of a substance, in itself, as *a colloid*. The word denotes, rather, a state of matter dependent on the relation of one phase to another, and is one in which all material can exist. It relates, as regards solids and liquids, to the state of subdivision of the former and its dispersion through the latter. Whether a solid is in a colloidal state or not depends not only on its state of subdivision but upon the viscosity of the liquid or continuous phase or medium in which it is dispersed. A substance which, owing to its degree of subdivision, would settle rapidly out of water, a mobile aqueous phase, may exist in a colloidal state as regards a very viscous bitumen, such as the heavy residuals of petroleum, which flow but slowly at ordinary temperatures. An example of the latter will be found in Trinidad asphalt, which contains a large amount of fine mineral matter, 25 per cent., which, all of it, exists in a colloidal state as regards the bitumen, although some of it is fine sand, of a size which will be retained on a screen of 100 meshes to the lineal inch. This comparatively coarse material is in a state known as colloidal, because the continuous phase in which it is dispersed may be regarded as a highly viscous liquid.

Clay, as it occurs in nature, is of a very varied character. It is, in deposits of different origin, in a more or less colloidal state as regards the water with which it is associated, no doubt depending upon the manner in which it has been formed, whether it is residual or sedimentary, the latter being usually the more colloidal.

It is recognized that clay can be readily diffused in water. Dry clay cannot be readily diffused through the denser forms of bitumen because the individual particles of the clay adhere to one another, and because they are covered with an adsorbed film of air or water which prevents its being coated with bitumen. For these reasons dry clay cannot be dispersed uniformly through such a viscous medium as a dense bitumen. If, however, the clay is originally thoroughly dispersed in water as a continuous phase it can then be emulsified with any bitumen which is sufficiently liquid at temperatures below that of boiling water to make it possible. On the removal of the aqueous phase from the emulsion by heating, the highly dispersed clay will then enter into the bituminous phase without difficulty and will then be dispersed therein in a colloidal state or as a colloidal solution of clay in bitumen.

Clay in a colloidal state can also be introduced in the same way with greater facility into the more liquid types of asphaltic bitumen. The amount, introduced in this way, may reach with certain oils as much as 60 per cent. Such a material may be used for fluxing the harder bitumens for the purpose of introducing colloidal clay into them in a simpler manner than by attempting to do so directly. With a sufficient amount of clay in a colloidal state in the flux, the latter has such stability that it can be shipped without packages. Combinations of asphalt and colloidal clay may be obtained in this way which present some extraordinary and valuable characteristics from an industrial point of view.

The native asphalts of a highly viscuous nature, and the heavy residuals derived from asphaltic petroleum, possess, however, very different capacities for maintaining clay in suspension in a colloidal state, and this capacity differentiates them in a striking manner, demonstrating the difference in character of the components of which these asphalts are made up. This is illustrated by the determinations of what may be called the capacity of various asphalts to maintain colloidal clay in suspension under different conditions. Colloidal clay was introduced into a number of solid residuals of various types of petroleum, by the addition of enough aqueous clay paste to result in a material which, after removal of the water, should consist of 67 per cent. bitumen and 33 per cent. clay. These materials were maintained in a melted condition, at a temperature of 325°F. in tubes for 24 hours. The sedimentation which, with the reduction of the viscosity of the continuous phase, went on in that period, appears from the following figures:

Source	Penetration	Per cent. Colloidal Matter Before Heating	Per cent. Colloidal Matter After Heating	Per cent. Sedimentation
Trinidad Residual	50	33.5	33.7	0.0
Bababul Residual	48	32.4	30.1	7.0
Mexican Residual	50	33.3	27.2	18.3
California Residual	50	31.8	23.8	25.2
Mid-Continental Semi-Paraffine Residual	51	33.8	21.7	35.8

Colloidal Capacity of Various Types of Bitumen

Mixtures of 67 Per Cent. Bitumen and 33 Per Cent. Clay, Introduced Wet, Maintained at 325 F. for 24 Hours

The colloidal capacity thus determined is a function of the character of the particular bitumen and also of its viscosity at the temperature concerned. The striking feature is that the residual asphalt prepared from semi-paraffine petroleum of the Mid-continental field deposited 35.8 per cent. of the clay at high temperature, showing the small capacity of paraffine oils to maintain clay in suspension in a colloidal state. At the other extreme a Trinidad residual deposits nothing under the same circumstances. A Bababul residual

*A paper read before the Western Society of Engineers at Chicago, November 20, 1916.

[1] "An Introduction to the Physics and Chemistry of Colloids," by Emil Hatschek, 1916. P. Blakiston's Son & Co., Philadelphia.
"The Chemistry of Colloids," by W. W. Taylor, 1915. Longmands, Green & Co., New York.
"Die Welt der vernachlassigten Dimensionen," by Wolgfang Ostwald, Theodor Steinkopff, Dresden, Germany.
"Handbook of Colloid Chemistry," by Ostwald, translated by Fischer, 1909. P. Blakiston's Son & Co., &Philadelphia.
"The Physical Properties of Colloidal Solutions," by E. F. Burton, 1916. Longmans, Green & Co., New York.
"The Technical Control of Colloidal Matter in Clay," Technologic Paper No. 23. Bureau of Standards, Washington, D. C.

prepared from a Venezuelan petroleum, which is heavier than water when it emerges from the well, deposits but 7 per cent., a Mexican residual 18.3 per cent. while the California residual deposits an increased amount.

As the film of bitumen which covers the mineral aggregate of a sheet asphalt pavement is formed at the temperature given, these data may convey some idea as to the capacity of the different materials for coating the grains of this aggregate, but too much dependence must not be placed upon them as there are so many other controlling features in relation to the character of the films. It is striking, however, that the Trinidad residual is so thoroughly differentiated from all the others, thus confirming the opinion, based upon service tests in regard to the unique character of this material.

If the same mixtures of bitumen and colloidal clay are examined in a 10 per cent. solution in carbon-disulphide, which has been submitted to centrifugal action, the results are equally striking.

Sedimentation of 10 Per Cent. Solutions on Centrifuging In Carbon-Disulphide

Source	Per cent Remaining in Suspension
Trindad Residual	2.23
Bababul Residual	1.91
California Residual	1.89
Mexican Residual	0.94
Mid-Continental Semi-Paraffine Residual	0.54

Colloidal Capacity of Various Types of Bitumen

In Mixtures of 67 Per Cent. Bitumen and 33 Per Cent. Colloidal Clay

The Trinidad residual again has the greater colloidal capacity, while the Mexican residual, under the conditions, shows a decided reduction in this respect, while the semi-paraffine, Mid-continental material, again has the smallest capacity. This capacity of different bitumens of the same consistency for maintaining clay in a colloidal state, under different conditions, is strong evidence of the fact that asphalt from various sources is of a different character.

Trinidad lake asphalt after the removal of the water by heating, that is to say, in a refined condition, contains about 35 per cent. of anhydrous mineral matter, as determined by ignition, all of which must have been in a colloidal state, since the amount found in all parts of the deposit is the same and this uniformity can only be accounted for on this supposition. If this asphalt is dissolved in carbon-disulphide or benzol to form a solution of varying degrees of concentration and centrifuged to remove the mineral matter which is too coarse to remain in the colloidal state, in a liquid of the viscosity corresponding to the concentration, the resulting solutions will be found to contain a percentage of colloidal matter varying with the concentration and viscosity. The data which have been obtained as the results of experiments along these lines are as follows:

Per cent Concentration	Spec. Grav.	Increase for 1	Absolute Viscosity	bsolute for 1
Benzol	.876	.....	0.00652	.....
1 per cent T.R.A.	.877	.0010	0.00654	0.00002
2 per cent T.R.A.	.879	.0020	0.00687	0.00033
5 per cent T.R.A.	.883	.0013	0.00759	0.00024
10 per cent T.R.A.	.889	.0012	0.00961	0.00040
20 per cent T.R.A.	.911	.0022	0.01269	0.00067
30 per cent T.R.A.	.930	.0019	0.04198	0.00257
40 per cent T.R.A.	.957	.0027	0.09477	0.00521
50 per cent T.R.A.	1.012	.0055	0.31800	0.02240
100 per cent T.R.A.	1.400	.0076	.....	.....

Characterization of Solutions of Trinidad Asphalt

Per cent Concentration	Refined per cent Colloidal Matter	Refined amount for 1 per cent
1 per cent	2.54	2.54
1 per cent	2.54	2.54
2 per cent	2.01	1.00
5 per cent	2.09	.42
10 per cent	2.73	.27
20 per cent	3.13	.16
30 per cent	4.19	.14
40 per cent	6.51	.16
50 per cent	10.69	.21
100 per cent	35.40	.35
In Benzol.		

Characterization of Solutions of Trinidad Asphalt

The percentage of clay in a colloidal state varies but slightly for concentration of from 1 to 10 per cent., but increases gradually above this. These changes are most strikingly brought out if the increase is calculated for 1 per cent. for the different intervals, as shown in the tables. The amount decreases gradually per unit of bitumen until the concentration of 40 per cent. is reached, when it again increases up to 100 per cent., which is not, however, a maximum.

It appears from these figures that this result might be due to irregularities in changes in the viscosity of the solutions under examination, with concentration, but determinations have shown that this is not the case, since the absolute viscosity increases in a perfectly regular way. The same may be said in regard to the increase of the specific gravity of the solution. On plotting these data it appears that the curves show that the changes in specific gravity are represented by a straight line, or approximately so, the curve for absolute viscosity by a paraboloid, and that for suspended solids by a slightly irregular paraboloid. It appears then that the increase in the amount of clay in a colloidal state is gradual for a lower but sharp for the higher concentrations.

The peculiar relations of colloidal clay and bitumen as demonstrated by the preceding data are of great interest. They serve to demonstrate the importance of the relations of surfaces and films and of the peculiar role played by matter in a colloidal state in connection with combinations of bitumen and mineral matter as employed in paving and road construction. It can be readily seen that the relations of water as a continuous phase and mineral matter in various degrees of dispersion can be interpreted along similar lines and are of importance to the engineer in connection with the stability of earth dams, fills, embankments and other structural relations of materials of this type. It is a subject which, in this direction, has received only superficial attention up to the present time.

The Hippocampus

THE interesting little fish known as the seahorse or Hippocampus, which has attracted much attention on account of its curious form and no less peculiar habits from time immemorial, is discussed by Dr. Charles R. Eastman, of the American Museum of Natural History, in one of the Smithsonian Annual Report papers just issued.

Occurring plentifully in the Mediterranean, the typical species was well known to the ancients; and owing to the wide distribution of the remaining thirty-odd species composing the genus, seahorses have now become familiar objects in most large aquariums of the world. They appear to be a weird combination of a horse's head and a body or tail of a caterpillar. It has been said that if a coiled worm were attached to the base of a chess knight the seahorse would be well imitated.

We owe to the late Dr. Theodore N. Gill, Associate in Zoology of the U. S. National Museum, a fine account of the life history of the Hippocampus, published in the proceedings of the U. S. National Museum in 1905. The movements, feeding and breeding habits of these creatures are all extremely curious, and are well described by Dr. Gill.

The most frequent position assumed is a state of rest, with the tail wound around the stem of a plant or other substance, and the body carried nearly or quite erect, but notwithstanding the apparent rigidity of its cuirass-like body armor, almost every other attitude consistent with such a form can be assumed. The body can be thrown outward or downward at various angles, the tail being wound around a plant in a double coil. Once in a while one eye may roll toward the observer, while the other may be passive or look backward or even in the opposite direction. The little fish can move its eyes independently of each other, and in entirely different ways. A comical effect is produced by the manner in which these fishes peer at some objects, reminding one of a very near-sighted person.

Releasing itself from its support it can progress slowly, still in a vertical position, its tail curved inward, its dorsal fin rapidly undulating, reminding one of a screw-propeller, and with its pectoral fins vibrating in harmony.

Incased as it is in an almost inflexible coat of mail, progression can not be effected by lateral flexion of the body as in ordinary fishes, and with the flexion in a vertical direction is limited.

With such limited powers of progression a nice adjustment of organs is necessary. One method is said to use an air bladder, comparatively large and always distended by a quantity of gas so exactly in harmony with the specific gravity of the body that this entire body is a hydrostatic apparatus of extreme sensibility. A proof of this is that if a single bubble of gas no larger than the head of a very small pin be extracted, the fish immediately loses its equilibrium and sinks to the bottom on which it must crawl until the wound has been cicatrized and a new supply of gas secreted by the internal membrane of the bladder. It is well known that the eggs of Hippocampus are taken care of by the male in an abdominal sac or pouch.

The name Hippocampus is derived from the Greek words *hippos*, signifying horse, and *kampos* or *kampe*, a caterpillar. And, in fact, the head is shaped and the neck arched like those of a horse, while the body or tail resembles a caterpillar.

One sixteenth century writer states that: Its size does not exceed a finger's length; it has a tough and rugose skin, and neither man nor fish of other kind esteem it as food. In color it is sometimes dark; in other cases white. It bears a small fin, a little elevated along the back, and another small one on the neck where it joins the head. The mouth is small and tubiform. Dead or dried specimens have the tail coiled inward, like that of a chemeleon; it is furnished with small, blunt prickles, and is of quadrangular section. The spinuos projections arise from transverse folds which cross the tail.

Certain authors profess that the ashes of Hippocampus when commingled with liquid pitch, tallow, or oil of sweet majoram, cure baldness and pain in the sides. An application of oil of roses into which the live animal has been dipped and killed is an efficacious remedy for chills and fever.

Dr. Eastman mentions alleged medicinal properties of Hippocampus, gravely set forth by Matthioli, Belon, Rondelet, Gesner and others. Aristotle does not mention the Hippocampus, and this word was used by the poets of classical antiquity as the name of a sea monster, half horse and half fish, on which sea divinities rode. It is probably in this character that conventionalized representations of the creature appear in Etruscan and other ancient works of art.

A curious confusion of this odd fish with some other species occurred years ago, when its identity was mixed with the Remora, or sucking-fish, also known as "Ship-stayer," which clove to ships and held them steadfast in the sea, as though the ships were aground, although the wind and waves strove to wreck them. Another story connected with the Hippocampus with the eel-like "Reversus," said to have a cap attached to its head with which it captured other fish and tortoise, and was therefore used by the natives, reported by Columbus for catching other fish. It also was once called "sea dragon," or "Zydeath," and again, from the Latin, "*Equus maris*," "Horse of the Sea," on account of the fact that these creatures were all supposed to die in the air or at least suffer when out of water.

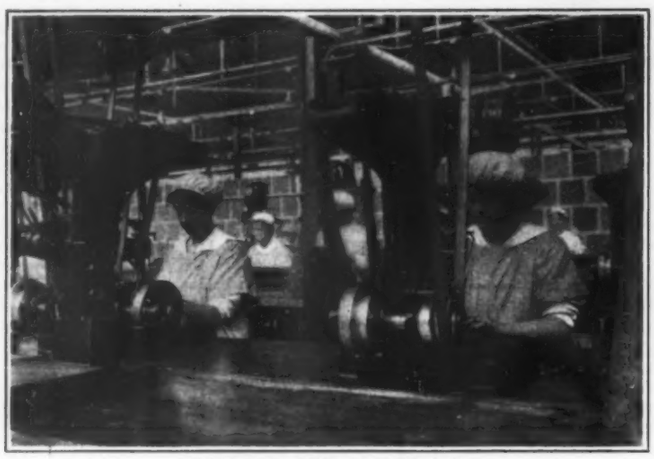
Passive State of Metals

THE results obtained by previous investigators, discussed in detail, are claimed to justify the view that passivity in all cases is caused by oxidation, but the existing theories are regarded as insufficient to account for the facts observed. It is submitted that the true cause of passivity is the formation of a higher oxide (compare Armstrong and Colgate, this J., 1913, 394) which is adsorbed by the metal to form a protective layer more noble than the metal itself. Very small amounts of oxide are considered sufficient to bring about passivity, and in most cases probably the oxide formed is stable only in the adsorbed state. The disappearance of passivity at high temperatures is thus accounted for by the decomposition of the oxide which accompanies diminished adsorption, and the slow change of E. M. F. as passivity develops is explained by the fact that the potential of the oxide produced has its maximum effect only when passivity is complete; other facts, such as those observed by Heathcote (this J., 1907, 899) are shown likewise to accord with the theory. When iron is rendered passive in nitric acid, it is supposed that $Fe^{\cdot\cdot}$ ions are produced and oxidized to $Fe^{\cdot\cdot\cdot}$ ions, and that then some of the $Fe^{\cdot\cdot\cdot}$ ions are further oxidized (probably to give the oxide FeO_3) and the higher oxide is adsorbed; the effect of vigorous stirring is to circulate the $Fe^{\cdot\cdot\cdot}$ ions before further oxidation can take place, and the metal therefore remains active. The protective oxide in the case of chromium is not higher than the trioxide CrO_3, for the metal becomes passive in a solution of chromic acid; it is probably the dioxide CrO_2. Lead was rendered passive without the appearance of a visible oxide film, but it is thought that the process is essentially similar whether an obvious coating is produced or not.—*Note in Jour. Soc. Chem. Ind. on a paper by C. W. Bennet and W. S. Burnham, in Z. Elektrochem.*

Hard Rubber Sponge

HARD rubber sponge is prepared from soft rubber sponge by further vulcanization. The stock is made up with sufficient sulphur to effect the transformation to ebonite, so that after producing soft rubber further vulcanization takes it over to hard sponge.

This material has an apparent specific gavity of 0.2 to 0.065, which is ½ to ¾ that of cork, and ¼ to 1-12 that of wood. It may be worked in any way customary with hard rubber, such as sawing, boring, machining, etc. It still has the cellular structure of soft sponge, and therefore its insulating properties are not in the least affected. Hard rubber sponge is suggested as an insulator for covering flasks, or ice box-walls. As it has considerable strength, it is proposed as a material for aeroplane framework and for automobile bodies.



Making parts of detonators for shells

View in a shop where small parts of shell fuses are assembled

New Work for Women Created by the War

A DEVELOPMENT of the war in Europe that has attracted widespread attention is the employment of women in munition factories, and more recently, owing to the shortage of workmen because of the large numbers of men that have gone to the front, intensified by the establishment of many new plants, the same system of employment of women has been put into operation in Canada, and may very possibly extend to the United States in case it becomes involved seriously in hostilities. Much has been made of this new phase of women's activities, and considerable surprise has been expressed in untechnical papers that women have been able to so quickly undertake work so foreign to their habits, and which has been generally thought to require the services not only of men, but men trained in mechanical operations; but to those familiar with the practical operation of plants where machine tools are employed there is nothing surprising in the fact that women can operate many classes of machinery successfully.

It is the prevailing impression among the general public that the great armies of men operating the machinery of our great manufacturing plants are "machinists," that is, men who have served at least a sufficiently long time in the shops to be skilled in the operation of machinery and tools, and to be familiar with mechanical processes generally; but this is far from the fact, and the number of such men, those who are capable of taking an ordinary working drawing and carrying out its many and often intricate requirements, is decidedly limited. Such men are in a class by themselves, and are generally known as "tool makers," and their province is to produce the special tools, jigs, fixtures and gages which, used in connection with machinery, control, guide and regulate manufacturing operations, and enable an ordinary, unskilled man to produce accurately made parts. In every shop operating on a manufacturing scale there are men known as "machine setters," whose duty is to prepare each machine to perform some particular operation, or series of operations. They attach the "fixtures" where necessary, adjust the cutting tools in their proper positions, and see that the required jigs and gages are at hand. Then in a very short period of time, often in half an hour, these men can show an entirely inexperienced man of average intelligence how to place the rough piece in the machine and start and stop the latter, and how to use the gages. After that all that the operator has to do is to put in the rough part and remove the finished article, and to test the same by means of fixed gages. This test is applied in most cases to every piece produced, and whenever any irregularity is found the operator reports his machine for readjustment. Naturally, in the course of time, an intelligent operator will learn to make minor adjustments for himself, but in the main he only goes through a simple, prescribed series of motions, with no necessity of knowing the reasons for the operations, or how the part he is making is to be used, or its functions. He is not a true mechanic, he does not act on his own initiative, he originates nothing.

It will be apparent from this explanation that if the parts to be handled are not too heavy, or the exertion of operating various levers or cranks does not require too great physical exertion, a woman can do the work as well as a man; and a woman's suppleness of hand frequently enables her to go through the series of manual operations more rapidly than most men.

There are, however, other considerations besides mere manual dexterity entering into the question of the employment of women as machine operatives, an important one being that of liability to injury, for a woman's mind does not grasp the mechanics of machinery as readily as the average man, and as a consequence is more liable to have her hands caught in the rapidly moving parts. Another question is the physical one of long sustained operation, especially in view of the fact it is seldom possible for a machine operator to sit down, particularly when tending several automatic machines. This latter problem has arisen in England, and in many cases it has been found necessary to shorten the hours of work considerably in shops where women are employed, besides making many provisions for their

Modern costumes of female factory workers

personal comfort and convenience that would never be thought of in the case of men, even by theoretical philanthropists. It is claimed, on the other hand, that the superior manual dexterity of the women enables them to turn out an equally great product in the shorter period of work. How true this is remains to be seen, for many rosy statements are given out in England in relation to war work for the consumption of the public that may have to be materially revised in the future; and, moreover, many things are done now, under war pressure, to attract women to the shops that would not be practical, nor possible, in the ordinary commercial operation of these works. The whole problem will have to be studied entirely anew after the war, when the necessities of the present circumstances, and the hysteria of the public has passed away.

The most serious feature of the employment of women in mechanical work, however, is an economic one. In England, France, Canada, and also in Germany, the movement is largely on a patriotic basis, and the wages paid to women are less than the men they replace received. After the war is ended, will women continue to seek this kind of employment? Will the employers consider them a desirable class of help? Will they give women greater wages than at present? And more important than anything else is the question of what will become of the army of men, with families to support, when they return from the war and find their places taken by women, and those mostly unmarried? The necessities of the present are laying the foundation for future problems of most serious, far reaching and revolutionary importance.

German Aeroplanes in the War

THE Fokker single-seater monoplanes, comparatively few in number, with which the Germans were scoring some successes early in the year, were really imitations of the French Morane-Saulnier monoplane, and their chief characteristics were their small wings and streamline bodies. They were fairly fast—probably about 110 miles an hour—and were good climbers—that is to say, they were not only capable of climbing rapdily but could reach a great altitude, two virtues not necessarily always present in one machine. That there was nothing very remarkable about them will be realized when it is pointed out that the French possessed, so long ago as the Gordon-Bennett race in 1913, monoplanes which did 130 miles an hour. These machines, it is true, were purely racing machines, which could be trusted only to the most skilful pilots, owing chiefly to the fact that their landing speed was extremely high. The same was true of Fokkers, which, by the way, although it is not generally known, killed quite a number of their own pilots. They were therefore entrusted only to picked airmen, and their usefulness was limited to short defensive fights over or behind the German lines. It was not, however, so much their speed as their tactics—lying in wait at a great height and then diving to attack our reconnaissance machines below—which, until they were understood, caused serious casualties on our side.

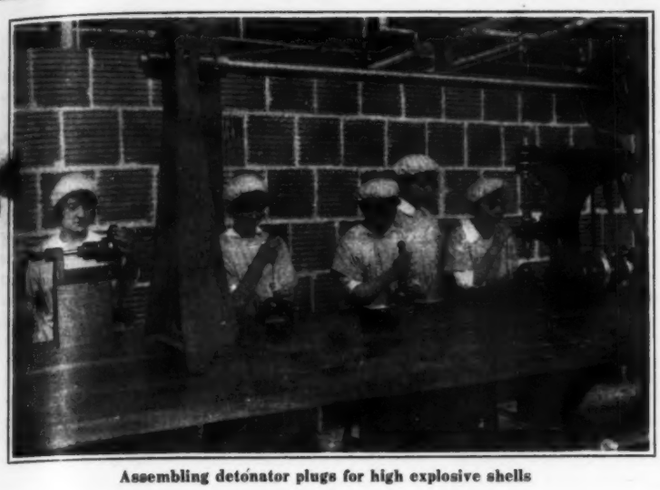
The successes of the Fokkers were soon countered by the Allies. In France the machine which played the greatest part in clearing the sky of Fokkers was probably the little single-seater Nieuport scout, a small biplane, the lower plane of which was quite diminutive in size, and in which the pilot could fire "through" the propellor as well as up over the top plane. Later in the year the French Spad began to come into evidence, and did some excellent work. Like the French biplane scouts, our own had the great advantage over the Fokkers that they had a much greater speed range and that therefore it was possible to find a greater number of pilots capable of handling them.

Within a comparatively short period the Fokker menace was well in hand, and several months then elapsed before anything startling in the way of speedy single-seaters appeared from beyond the Rhine. Recently, however, Germany appears to have made another energetic effort with new makes of machines, the capabilities of which, although by no means hopelessly outclassing ours, are sufficiently excellent to show her determination to contest the Allies' supremacy in the air when activities shall begin again in the spring of the year.

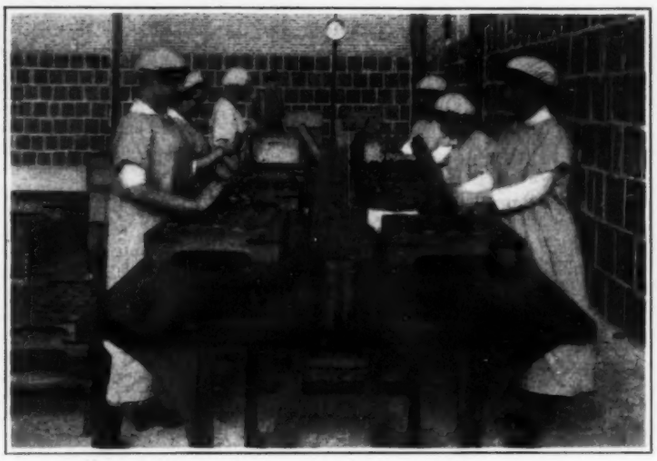
When the Germans got over the Fokker disappointment and again began to show themselves, it was on machines built on similar lines to those employed by the French and by ourselves. Thus, for instance, the Fokker biplane was a machine resembling closely the scouts of the Allies. Another machine moulded on French and British lines was a certain type of Ago biplane, propeller boss enclosed in a hemispherical nose-piece.

Of a much more recent pattern is the little Halberstadt biplane, which is a small single-seater scout, differing from ours, however, in that it has two pairs of inter-plane struts on each side. It is driven by a large stationary engine of the Argus, Mercédès, or Benz type, probably according to which make happens to be available. Like the majority of recent German machines, it is fast and a good climber, being credited with a "ceiling" of some 18,000 feet to 20,000 feet.

In the early days the German never paid any great attention to high speed, concentrating more upon questions of stability, and leaving the quest for speed to the French. As, however, speed became of greater and greater importance, the Germans at first tried to obtain it by increasing the power, but, however, without yet seriously attempting to reduce head resistance. In the latest specimens captured—among others, in the Albatross scout—everything appears to have been done to reduce resistance to a minimum. The rectangular section fuselage is streamlined with aluminum, and this reduction in resistance, coupled with the power of the great water-cooled engine, greatly improves the performance.—*Engineering Supplement of the London Times.*



Assembling detonator plugs for high explosive shells



In the packing room of a Canadian shell factory

The Training of the Analyst*

By Frank Browne, F.I.C., Formerly Government Analyst, Hongkong

THE education of the scientific man, to be of practical utility, should have the broadest foundation. Excellent as the instruction may have been, the period of tuition is with many, probably with most students, too much curtailed. A chemical student on leaving college may have obtained a very good degree, and yet may know little of the practical side of the analytical profession. Is it not true that to many such even the recognition of a simple salt of a common metal is by no means easy, and is arrived at frequently only after an undue expenditure of time? And is there possessed that thorough knowledge of the British system of weights and measures so that ordinary problems can be worked out without a long circuitous process of calculation? Or give a sample of boiler incrustation and ask for the constituents present, and roughly the proportion of each. Is it not a fact that, although a correct answer may be given in, the amount of time expended has been altogether disproportionate to what should be taken over such an examination? It is not here asserted that all newly qualified men are lacking to the extent indicated, but there seems to be with many a deficiency of analytical experience, which is likely to hamper them in after life. This article is not written for any controversial purpose, but is rather the reflections of one who, after long absence from England, is able to take a detached view of what seems to be some defects in our educational system as applied to the analyst. A graduate who has adopted a chemical career may go direct from his college to a public analyst's laboratory, and there it may be that he will not suffer much from having had academic training only. He would be given work to suit his capacity, and as he obtained more experience the analyses given him to perform would become more difficult. There, with a large variety of examinations, the processes used will be of a standard and rapid kind, and after a year or two the assistant of ordinary ability becomes highly useful. Take the case of this same student supposing he has entered a works laboratory. Here, also, by constantly going over routine processes, he may become very helpful to his employers. But here there may be plant difficulties to be solved, and now, although well trained and capable of carrying out analyses satisfactorily as long as he is given unlimited time, he may be found wanting on account of his lack of knowledge of good rapid analytical methods. Here, for the most part, difficulties have to be solved with as little interference as possible with laboratory routine, and it is reasonable to suppose that an employer feels disappointed when an assistant, well recommended from his college, seems unable to carry out in a commonsense practical manner a very ordinary analysis. Perhaps it is desirable to go outside routine work and ascertain accurately the composition of some new material used on the works, such as an oil, alloy, or cement. Now, in a laboratory where such substances are examined frequently, the analysis would be concluded after at the most three or four hours. In a laboratory where such an examination is outside the usual scope, much longer might be necessary, but at any rate the training of an analyst ought to be such that he can work out a process from a work of reference, and apply it successfully to the substance in question without interfering greatly with his routine duties.

It may be of interest to young analysts to know that almost any system of analytical examination may be so carefully studied with a view to speed as to be almost incredibly shortened. A cement analyst informed me that, working single-handed, he was able to determine quantitatively in one hour the silica, iron, alumina, lime, magnesia, and loss on ignition of ordinary cement. Another wrote me that he was now able to determine the amounts of antimony, iron, lead, and arsenic in *antimony ochre* in two hours, and the same in two *stibnite* ores in three hours. Perhaps a few remarks as to speed in performing analyses may be found useful. It may frequently be obtained by bearing in mind that it is most helpful in performing a new analysis to write down in what direction the process may perhaps be shortened by the introduction of, say, a volumetric for a gravimetric process, which is nearly always possible in inorganic work. And when a good process of estimation has been arrived at it may be better understood by ascertaining the effect of varying conditions—such as the concentration of the solution to be examined, the strength of the volumetric reagent to be added, and the rapidity with which the latter may be run in, and so on. In this way sources of error may be discovered and guarded against and invaluable experience obtained. On no account should it be considered that no improvement is possible in a process, even although such is taken from a good textbook. Many excellent methods of examination are locked up in laboratory journals, and are not likely to be published except, perhaps, after the lapse of some years. When physical constants, such as the relative density and refractive index, are to be determined frequently, a table of corrections for temperature is simply invaluable.

Sometimes in routine examinations the use of a pipette to deliver a constant weight (*Chemical News*, July 28, 1916, p. 41) may prove a great time-saver. Also standard solutions can be made often so that 1 cc. corresponds to 1 per cent when 1 grm. of substance is taken. This is a good system, and saving of time and error. With every analyst the time comes when, from some cause or other, there is an apparent deficiency of work in the laboratory. This period in reality is most valuable for maintaining efficiency. Everyone during his busy days will see matters, such as the testing of new processes, that cannot at once be attended to, and these inquiries should be entered at the end of his note-book for further consideration when opportunity permits.

Now, the student in his academic course of practical work has no time to do more than carry out typical analyses, so that the writer desires particularly to support the useful and practical recommendation of Mr. A. Chaston Chapman, formerly President of the Society of Public Analysts and Other Analytical Chemists, as set out in his Annual Address (*Chemical News*, 1916, cxiii, 69) that:

"So far as our colleges are concerned I feel very strongly that a more thorough training in analytical chemistry is desirable, and I would in addition venture to suggest that the present curriculum of those chemical students who intend to become professional chemists should whenever possible be amplified so as to include a further year of study.

"During this post-graduate year the student should be trained by thoroughly competent and specially selected teachers under conditions approximating more to those of the technical than to those of the academic laboratory."

It is a matter of opinion as to what would be the course of study during this year that would develop best the powers of the student. The program might include:

Water analysis for industrial purposes. Fuel (coal), determinations of volatile combustible matter, water, ash, sulphur (by several methods), and calorific value by calculation and by experiment. Oils, fats, and waxes—determination of constants and examination of several adulterated specimens. Alcohol—estimation in beer, wine, and spirits, by several methods, and determinations of very small quantities in liquids. Metals and alloys—quick methods for ascertaining the amount of the principal metal in commercial tin, lead, antimony, copper, zinc, and in molybdenite. Also working over a few alloys of these metals in order to determine the proportion of each constituent metal. A good working acquaintance with the microscope, polarimeter, various forms of refractometer, and spectroscope.

In this course some time should be given to the recognition of substances, organic and inorganic, and if the student does not feel able to determine with precision after a few minutes the nature of any ordinary simple inorganic substance not requiring fusion with other substances to bring into a soluble form, he should practice until he finds out where he is deficient. As regards so-called insoluble substances, those characteristic should be studied individually together with the best means of recognition. Commonly occurring organic substances should be examined so that a fair number may be recognized. Out of the way compounds may occasionally be met with, but for these considerable help ought now to be obtained from the text-books which should have formed, or are forming, part of the student's ordinary reading course. Students would now have an opportunity of getting more proficient with the slide rule in their calculations. And a good sound knowledge of the British system of weights and measures might be acquired by expressing some results in grains per gallon, per pound, or per cubic foot. In order to promote business habits the students should be expected to be industrious and to observe closely laboratory hours. After the completion of each kind of analysis they should, from their laboratory note-books, either card-index the process used, or adopt some other means of permanently recording their work in good detail.

Students who have been through a course such as that suggested would read current literature with much more interest, and would ever be seeking out new methods and labor and time-saving devices. Moreover, they could not fail to obtain a sounder knowledge also of theoretical and physical chemistry—a knowledge which, in their careers, will allow no technical process coming under their cognizance to pass without understanding thoroughly, as far as it is possible, the chemical or physical effect produced by each and every substance employed. Such a course could not fail to improve the capacity of a student for research. It would give him a good sound grip of analytical chemistry, and would tend to render the student's knowledge much more assimilable, and the student himself much more valuable to his future employers.

*Chemical News.

Measure of Atmospheric Pressure

OFFICIAL information has been received from Paris that from January 1, 1917, the millibar (1000 C. G. S. units) will be used in the publications of the Bureau Central Météorologique for atmospheric pressure, instead of the millimetre of mercury. The same unit has been in use in the publications of the British Meteorological Office since the beginning of 1914; the Colonies of British Guiana and Mauritus have already adopted the unit, and it has also been used in some of the publications of the Weather Bureau of the United States, of Harvard University (Blue Hill Observatory), and of Berkeley University, California. The question raised by Prof. McAdie, of Blue Hill, as to whether the proper name for the unit is not a "kilobar" has still to be considered, on the ground that the name "bar" was already appropriated by chemists to mean 1 dyne per square centermeter. It is one of the questions which should have been discussed at an international meeting projected for September, 1914.—*Nature.*

The Influence of Some Elements on the Mechanical Properties of Steel

INFLUENCE *of carbon.* The results obtained by different investigators in determining the influence of varying amounts of carbon and of varying heat treatment on the mechanical properties of pure carbon steels are summarized. Comparison is difficult owing to the fact that in some cases the dimensions of the test-pieces submitted to tensile tests are not always given. It is suggested that when recording the elongation, the ratio of length to area should invariably accompany the figures, for without this the percentages of elongation are of little value. The yield point is often given as the elastic limit, yet the latter may be in some cases only half the former. When using the terms normalizing or annealing, the temperature of heating and the time of cooling to below visible redness should be recorded. Neither term should be used without definition. After allowing for the influence of the small amount of carbon present in the purest commercial soft steels, it has been calculated that pure iron has the following properties: Elastic limit about 9 tons per sq. in.; maximum stress 17 tons per sq. in.; elongation (length/area = 8) 51%; reduction in area 84%. The effect of 0.1% C on very pure steels containing less than 0.9% C, with only small amounts of manganese and silicon, and in the normalized condition, appears to be: yield point increased 1.68 tons per sq. in.; maximum stress increased 3.89 tons per sq. in.; elongation reduced 4.35%; reduction of area reduced 7.40%. In the manufacture of ship and boiler plates the carbon must be higher in the thicker plates to get the same static tests, since the more work, and the lower the finishing temperature, the higher will be the tenacity. *Normalizing.* When steel is heated to definite temperatures well above all critical points, the carbon and iron become perfectly interdiffused. If then the steel cools down from the maximum temperature to below redness (say, 450° C.) in not more than sixteen and not less than eight minutes it may be regarded as normalized. Published results lead to the conclusion that when small pieces of steel are normalized by heating just up to 870° C. and 950° C., and then cooled in air to about 400° C. in ten minutes, high yield point and tenacity are obtained without material reduction in the ductility. In normalizing large steel castings it is the general practice to heat to about 900° C., but it is clear that the tests of small pieces of steel cast in connection with large castings will not indicate the properties of the larger mass. To obtain the best static mechanical properties it is not sufficient to heat a steel to just above the point at which cooling records and the microscope indicate the interdiffusion of carbon and iron to be apparently complete, but the temperature must be raised at least 50° C. beyond that point. *Hardening and tempering.* The best all round results obtained by Brinell with Swedish steels containing 0.18 to 0.44% C were got by quenching from 1000° C. in water at 20° C., and afterwards tempering at 650° C. A steel with 0.65% C gave the best results by quenching at 850° C. in oil. There would be great danger of water-cracking if large masses were quenched from 1000° C. in water; oil quenching at 1000° C. for low carbon steels, and 850° C. for steels with 0.3 to 0.65% C, followed by tempering, would be safer, and it is probable that better results would be given by quenching from 900° C. For low carbon steels with 0.2 to 0.4% C, it is safe to heat to, but not soak at, 900° to 950° C. before quenching and tempering, and to heat to gradually lower temperatures as the carbon rises. When hardening plain carbon steels for cutting purposes, the quenching temperature should never exceed a few degrees above the critical point Ac 1-2-3, that is, about 730° C. For hardening razors and fine cutting tools, the theoretical point to which they should be heated is 735° to 740° C., but in practice it is found safer to exceed this, though it is not usual to heat such material above 760° C. Carbon tool steels if quenched from 900°—1000° C. would be useless for cutting purposes, and would have a glaring coarse fracture when broken, and be exceedingly fragile, yet steels with 0.6 to 1% C give good mechanical results if hardened at 1000° C. and afterwards tempered at 550° C. Tests have shown that steels normalized at temperatures that give the finest structure have a lower yield point than steels that are normalized at much higher temperatures and which have a coarser structure. The temperatures suitable for hardening and refining are, therefore, lower than those best for normalizing, and for hardening and tempering. Curves are given showing the temperatures to which, theoretically, in the author's opinion, pure carbon steels should be heated (1) to obtain the finest structure and for hardening tools, and (2), when heated for oil hardening and tempering to get the best mechanical properties. *Influence of phosphorus.* The effect of phosphorus, within certain limits, appears to be comparable with that of carbon, but the effect of carbon is the greater in reducing the ductility. The effect of 0.1% P as determined by Stead and d'Amico respectively is: yield point raised 2.5 and 2.3 tons; maximum stress raised 2.4 and 4.1 tons; elongation reduced 0.7 and 1.36%; reduction reduced 1.5 and 3.8%. A certain amount of carbon (about 0.25 to 0.35%), when present in steel containing 0.2 to 0.5% P, causes the steel in setting to be much more finely crystalline than when phosphorus is absent, but the reverse is the case when little or no carbon is present. In the forged steels the crystalline structure is usually the finer in the phosphoretted steel. There is no reliable record showing that sound steel rails containing from 0.07 to 0.09% P break on the track more frequently than those containing less phosphorus. Phosphoretic rails undoubtedly resist wear better than similar rails with less phosphorus present. Phosphoretic steel is most useful in small amount in tin-plate bars, as it prevents the sheets sticking together during rolling, and it is used in larger quantity in low carbon steel for bicycle parts. It confers on steel the important property of giving clean and bright surfaces when turned in the lathe, and moreover increases the elastic limit and tenacity. The quantity required to give good machining property is usually from 0.13 to 0.20%. Phosphorus alloyed with iron makes the metal less liable to corrode, and in that respect is useful. Probably the great variations in the mechanical properties of phosphoretic material can be explained by the difference in structure, for it has been proved that the same steel or iron can be made very brittle or comparatively tough according to whether the structure has been made fine or coarse. It is much more important to have a fine structure in phosphoretic material than it is in ordinary steel low in phosphorus. *Phosphorus in wrought iron.* Although wrought iron containing 0.4 to 0.5% is liable to develop dangerous crystallization if highly heated, and in the neighborhood of welds, the presence of 0.10 to 0.15% P does not lead to that result. The best Yorkshire and Staffordshire irons contain phosphorus between these lower limits, and for structural purposes are superior to the best Swedish wrought irons, as the phosphorus in the former raises the elastic limit and makes the iron more easy to weld, and gives a higher yield point and tenacity. Carbon being always low, the phosphorus takes its place in conferring on the iron these useful properties. When the phosphorus reaches 0.4 to 0.5% the iron becomes brittle, and it is impossible to refine the coarse crystalline structure by heat treatment. Refining of the iron can only be effected by forging. *Influence of sulphur and manganese.* Sulphide of iron is deadly in its effect upon steel, whilst sulphide of manganese is comparatively harmless. The latter is exactly equivalent to the cinder in wrought iron, and in consequence steels containing it bend to a much greater extent in the direction of rolling than at right angles to that direction. The bad character of sulphur was earned in the early days of steel making owing to the difficulty of getting a sufficient quantity of manganese into the steel without unduly raising the carbon. In a most exhaustive series of tests made by Brinell a steel with 0.15% S gave the best impact tests, better far than a similar steel containing only 0.015% S. A steel containing 0.5% S and 1% Mn rolled and worked perfectly. When steel becomes stressed transversely to the rolling direction in use, the sulphur should be low, but when it is stressed in line with the rolling direction, as in rails and axles, and for material that has to be submitted to sudden shock, sulphur is not a disadvantage. Steel high in sulphur resembles wrought iron and is more or less fibrous. The more sulphurous a steel, other conditions being constant, the more rapidly is it attacked by acid solvents, owing to the great solubility of the manganese sulphide. After the threads of the latter are dissolved away, the acid attacks the walls of the holes so produced. The so-called porosity test, in which cross-sections of steel are immersed in acid for a given time, is a suitable one for roughly detecting sulphur, but not porosity. It is possible that high sulphur may be conducive to increased corrosion by the oxidation of the manganese sulphide to oxides of manganese and sulphuric acid, the acid formed then attacking the iron. *Influence of silicon.* The effect of silicon up to about 0.7% is not very pronounced either one way or the other, and it is doubtful whether any difference could be detected in steels varying in silicon between 0.05 and 0.30%. Silicon produces soundness in cast steel and on that account is now largely used. Owing to its use, also, basic open-hearth steel now approaches more nearly in good general properties to acid open-hearth steel than before silicon was added. Silicon up to 1.75% increases the yield point and tensile strength, and does not impair the ductility, but beyond that point increase of tenacity is only obtained with a serious loss of ductility. *Influence of copper.* The evidence is overwhelming that small quantities of copper, say about 0.5%, have little or no material influence on the mechanical properties of steel. What small effect copper has is in its favor. It raises the yield point and tensile strength and has little effect on the ductility. Some of the finest tool steel ever made contained 0.2% Cu. Even small quantities of copper make steel more resistant to acid-corrosion, and there is much evidence that copper in steel sheets preserves them from general corrosion. *Influence of tin.* Sensible quantities of tin increase the hardness of steel when heated and also increase the yield point and maximum stress of the cold metal, but have not nearly so great an effect as carbon and phosphorus It is doubtful whether 0.05% Sn would have any material influence on the properties of structural steel. Detinned scrap should not contain more than 0.5% Sn as a maximum. Results of tests show that tin in sensible quantity must be avoided, as it tends to make steel very difficult to roll, and hard and stiff when in the heated state.—*Notes in the Journal of the Society of Chemical Industry from a paper by J. E. Stead read before the Iron and Steel Institute.*

The Contamination of Running Water with Tubercle Bacilli

ABOUT three years ago *The Medical Record* had occasion to call attention to the work of Laird and Kite of the Trudeau Sanatorium by which they demonstrated viable tubercle bacilli in the feces of 90 per cent of patients with open lesions. At that time we spoke of the danger of sewage in the spread of tuberculosis and urged the adoption of measures taken to disinfect sewage emanating from tuberculosis sanatoria. Additional evidence is now submitted by Brown, Petroff, and Heise (Trans. Natl. Assn. Study & Prev. Tuberc., 1916, xii., 287), who have investigated the water of the river which carries off the sewage from Saranac Lake. They found no acid-fast organisms in the water above the outlet of the sewer. Below that outlet, however, they found acid-fast organisms in smears made from the water obtained as far as three and one half miles away. Material obtained 2.9 miles below the sewer on a cloudy day produced infection when inoculated into guinea pigs. When obtained on a sunny day the material apparently contained no living tubercle bacilli. The tubercle bacilli are so much more resistant to the ordinary means of disinfection than are most of the other pathogenic organisms that it is probable that they survive longer under these conditions also, and it is conceivable that they may at times constitute a distinct menace to the health of a community along the banks of the stream. It is possible that communities in this country will some day stop the pollution of river water and come to a realization of the importance of sewage-disposal plants as an aid to the preservation of the general health. It is evidence of this kind that ought to further such a desirable end.—*Medical Record.*

A New Horned Snake

VISITORS to the Reptile House have been puzzled by a remarkable looking rattlesnake, that recently arrived from Texas. This specimen is about six feet long and has a stout horn about an inch in height, apparently growing from the top of its head. A small species of rattlesnake inhabiting the arid regions of our Southwest has enlarged scales over the eyes that resemble horns, but the Texas reptile is a manufactured monstrosity. A snake fancier, living near the Texas-Mexico boundary line, conceived the idea of thus ornamenting rattlers for sale, and this is one of his first specimens, which he sent north as a gift.

The operation of attaching the horn, which is a rooster's spur, is a really ingenious surgical feat. By slitting the skin of the snake's head and leaving a certain amount of skin around the base of the spur, the latter appears to be grafted and to receive nourishment. We are awaiting the period of the shedding of the snake's epidermis, in expectation that a certain amount of sloughing will involve the horn during the process.—*Bulletin of the New York Zoological Society.*

Boiler Efficiency

Transfer of Heat to the Plates

THE aim of all boiler design and working should be to produce safely a definite quantity of steam at a fixed temperature and pressure with a minimum cost in fuel, standing expenses, and labor. An examination of the various costs connected with steam production will show that by far the largest factor is always the cost of the fuel. Especially is this so at the present time. Industrial concerns which before the war were paying 8s. a ton for fuel are now paying at least 20s. a ton, and the coal cost is quite 90 per cent. of the total steam production cost. It is important, therefore, in most cases at any rate, that economy of fuel should be the primary consideration in the design and operation of the steam boiler.

Assuming that the best value has been obtained for money when purchasing coal, there are two distinct problems to be solved in order that the maximum weight of steam may be produced for a given weight of fuel. These problems are (1) to obtain from every pound of fuel the highest percentage of the heat units; and (2) to transfer the maximum percentage of the heat units so obtained to the steam. The first is the furnace problem, and for its solution every endeavor must be made to obtain perfect combustion of the fuel. Furnace design and the supply of coal and air must each receive the most careful consideration in order to ensure the liberation of the largest amount of the heat units contained in the fuel.

The heat, so obtained is partly radiated direct to the heating surfaces from the hot bed of fuel, and partly is given up to the products of combustion, which, in turn, are led over the heating surfaces and there part with their heat. In the transference of the heat from the flue gases to the water resistance is offered at at least four points. There is resistance to the heat (1) entering the plate; (2) passing through the plate; (3) passing through any scale or sediment on the water side of the plate; and (4) passing from the scale or plate to the water. While each detail connected with any of these main problems is of great interest, the present article will deal only with one—namely, the resistance to the heat entering the plate, and particularly as this applies to fire tube boilers. This portion of the heat travel is the most troublesome, and offers by far the largest resistance; consequently the temperature head necessary to cause the heat to leave the gases and enter the plate is larger than at any other portion of the path.

Now, on account of the great resistance offered to the heat at this portion, and the relatively easy passage from the plate to the water on the opposite side, it would appear that attempts to increase the surface on the fire side, the area of plate exposed to the water being left the same, would lead to higher efficiency in the heat transmission. Further, a moment's consideration will show the importance of bringing the whole of the hot gases into intimate contact with the heating surfaces. Williams showed, long ago, that it is possible for a stream of hot gases to pass through a boiler tube without any but the outer layers in contact with the plate giving up their heat, the central portions of the stream passing right through the tube without any reduction in temperature. It is obvious, therefore, that, to prevent this, it is desirable to break up the stream and cause the gases to pass through the tube in such a manner that intimate contact between gas and plate is assured.

The modern idea with regard to the cause of the high resistance on the fire side of the tube is that clinging to this surface is a layer of cool gas through which heat must pass from the hot flue gases to the plate. As this layer is practically stationary the heat must pass through by conduction, and as gases are bad conductors of heat great resistance is offered. It is evident, therefore, that if the gas film could be detached and the hot gases brought more intimately into contact with the surface, the heat would pass very much easier.

As a matter of fact, the improvements and experiments made in order to increase the efficiency of the transmission from the hot gases to the plate have been along the three lines indicated above:—(1) Increasing the plate surface exposed to the gases; (2) breaking up the continuous stream of gases passing through the tube; and (3) detaching the film of gas adhering to the fire side of the plate.

The first attempt to increase the heating surface on the fire side was made in 1840 by Williams by means of "conductor pins." These pins were fixed at intervals along the plate and projected into the tube among the hot gases, thus increasing the surface exposed. In one series of experiments described by Williams, he placed 22 pounds of water in each of two small boilers and allowed the products of combustion of 30 cubic feet of gas to pass through each boiler in 2 hours 40 minutes. In one boiler the tube was fitted with conductor pins, while in the other the tube was perfectly plain. The results obtained were as follows:

	Water evaporated	Temperature of exit gases
Plain tube	4 lb. 14 oz.	466 deg. F.
Conductor pins fitted	7 lb. 13 oz.	320 deg. F.

Williams was so satisfied with his experimental results that he fitted these pins in many of the boilers under his charge. After experience in actual practice with these boilers, he wrote:—"The principle of these heat conductors is too self-evident to avoid adoption hereafter in all descriptions of vessels where heat has to be communicated or abstracted." But owing to practical difficulties in cleaning and examining the flues into which these conductor pins projected, their use did not long survive the inventor. A later arrangement—the well-known Serve tube—has, however, survived, and is in use in many boilers at the present time. The internal longitudinal ribs in this form of tube increase the surface almost 100 per cent. over that of the plain tube. Tests made on two large marine boilers, one fitted with plain tubes and having a total heating surface of 956 square feet, and the other fitted with Serve tubes and having a total heating surface of 1,536 square feet, showed that with the same coal consumption in each boiler the water evaporated per pound of coal used was 1 pound to 1½ pounds more in the boiler fitted with the Serve tube than in the plain tube boiler.

The second method of dealing with the problem is to break up the gas stream, cause the whole of the gas particles to come in contact with the heating surface, and deflect them so as to give direct impact on it. Direct impact of the gases after combustion is complete should be encouraged, as experiment shows that a square foot of heating surface on which the heated gases strike direct is equal to four square feet when the direction is diagonal, and double that amount when the current lies parallel to, or in the same plane as, the plate surface.

In order to break up the gas stream and cause direct impact of the gases it is necessary to insert some form of apparatus in the tubes which will give the gases the desired motion. Marine engineers have used such an apparatus, known as a "retarder," for half a century. In its simple and most commonly used form it consists of a strip of steel or wrought iron, bent into spiral form and inserted in the combustion ends of the tubes.

Some years ago an attempt was made to use a spiral retarder in the flues of a Lancashire boiler. The spiral was made of a number of special firebricks threaded on a steel rod, the spiral having a diameter equal to that of the flue and being about 8 feet long. The retarders were built up immediately behind the bridge, and tests made showed an evaporation of 1 pound to 1½ pounds of water to 1 pound of coal more when they were in use than before. In this arrangement, however, besides the advantage due to the breaking up of the gas stream, there was another important advantage in that the firebrick retarder acted as a splendid combustion chamber, and no doubt part of the improved result was due to this cause. It is of interest to note that this apparatus never passed the experimental stage on account of the difficulty experienced in obtaining suitable brick slabs which would remain sound for even a short period.

Other forms of retarders are known to marine engineers. The Hawke consists of a short plug fitting into the tube and dividing the gas into three streams, each of which has a slight spiral motion. The West is similar in design, except that it divides the gas into four streams. The Scott consists of a circular cap fitted into the end of the tube and having its lower portion cut away so as to give suitable passage for the gases. This last form can be placed on bars and inserted in any row of tubes, so as to make the most efficient combination for the gas passage. Tests on cross-Channel boats fitted with it showed a sustained saving of coal of 9½ per cent.

One of the most recently introduced retarders consists of a number of guide valves, which are slid on and secured to an iron bar. These valves can be regulated on the bar as far as distance apart and angle are concerned, and the whole easily inserted and withdrawn from the tubes. Instead of the gases having a spiral motion as in other forms of retarder, they will have a smooth, wavelike motion through the tubes. The valves are cut away on the lower side of the bar so that the ashes can be removed from the tube without withdrawing the retarder. Tests made with this apparatus in the boilers of a fishing vessel gave a coal saving of 10 to 11 per cent. as compared with the plain tube boiler.

In connection with retarders it should be mentioned that marine engineers make use of them for another purpose than the breaking up of the flow of the gases in a particular tube. Experience proves that in the return tube marine boiler the draught is more sluggish through the lower tubes and that the main path of the gases is therefore through the upper tubes. By fitting retarders to the whole of the upper tubes the gases are caused to take the more easy path through the lower tubes with advantage both to combustion and to water circulation.

The third method mentioned of increasing the heat absorbed by the plate is by detaching the air film. Experiment and experience prove that this can best be accomplished by causing the hot gases to scrub vigorously the heating surface, or, in other words, by passing them over the surface with a high velocity. The advantage of high gas velocity was first pointed out by Hudson. The best-known experiments were made by Nicholson on a Cornish boiler, and were later confirmed by Longridge. The boiler in question was 6 feet 6 inches in diameter and 26 feet long. Fitted into the rear end of the flue was a cylindrical vessel 10 feet long and with a diameter only 2 inches less than that of the flue. Through this annular space, 1 inch wide, 10 feet long, and 40 inches in average diameter, all the products of combustion were drawn. When burning 1,200 pounds of coal per hour and using 15 pounds of air per pound of coal the gases were reduced in temperature in passing through this annular space from 2,300 to 800 degrees F., and the heat given up was 34,400 B.Th.U. per square foot per hour, which is eight to ten times the rate of heat transferred usually found in practice. The gas speed through the annular space was 330 feet per second, which is also about eight to ten times the usual rate. Nicholson claimed, therefore, to have proved, in a practical manner, the law that "the rate of heat transferred from a gas to a plate is directly proportional to the speed of the flow of the gases."

Similar results were obtained on experiments made on small tubular boilers by the Technological Branch of the United States Geological Survey. Another interesting point brought out by these experiments was that the boiler efficiency at first falls with the increase of the gas velocity, and then, at a certain figure, remains constant for all increases of speed. The velocity at which this change takes place may be termed the critical velocity, and the result is no doubt due to the fact that past this critical velocity the gas stream naturally breaks up, and more intimate contact with the heating surface is obtained. It is questionable, however, whether tests on large boilers would bear out these results.

In actual practice the attempts made to use the above well-known facts are to be found in the application of retarders to marine boilers and in the use of the Serve tube in both marine and land boilers. So far, the advantages to be derived from the higher gas velocities have not led to any strong movements for their use. No doubt, the fact that such high velocities necessitate the use of forced or induced draught arrangements of high power has prevented its development, as the added complication and expense will not encourage the average engineer to try such a plant. Providing enough heating surface is put into any design of boiler the temperature of the exit gases can be brought down to very little over the steam temperature, but such a boiler would not be a commercial success in meeting the demand for efficiency and capacity. This demand, however, will lead to development along the lines indicated above. The facts are well established, and it is possible to increase greatly the capacity of fire tube boilers and, at the same time, obtain high efficiency.—*London Times Engineering Supplement.*

Geared Turbines

GEARED steam turbines are making great headway in the domain of marine engineering. Last year of nine turbine-engined vessels built in England, with a view to classification in Lloyd's Register Book, six had geared turbines. At the present time, with the same object in view, there are fifty-two vessels under construction in which geared turbines will be fitted. Of these twenty-five will have Parsons single-geared turbines and twenty-seven will be equipped with Curtis double-reduction geared turbines.

The Value of High-Level Meteorological Data—I*

In Forecasting Changes of Temperature

By S. P. Fergusson[1]

THIS Bulletin contains the results of a study of meteorological phenomena at different heights, undertaken with the object of determining, if possible, the value of upper-air data in forecasting frost. The material employed chiefly consists of records obtained simultaneously on the summit of Mount Rose and at stations in near-by valleys. Analyses of these records have been compared with results of similar researches conducted elsewhere.

The phenomena under consideration are very complex, and, in order to keep within the limits of a bulletin of this kind, this paper necessarily has been restricted to the most important features of the subject investigated.

Records of temperature and pressure were obtained from a thermograph and barograph of the Richard pattern from 1905 until 1911, except during a part of 1910, when changes in the management of the work were under consideration. The instruments usually worked for about nine days with one winding of the clocks, and as the mountain could be ascended on an average about twice in a month, the records were not continuous, but probably cover more than one-half of this period. Extreme temperatures were obtained from maximum and minimum thermometers read at the time ascents were made. Also, there were occasional observations of wind velocity from a Weather Bureau anemometer, and records of cloudiness, precipitation, storms, and optical phenomena in the form of notes.

In 1907 the writer, then at Blue Hill Observatory, was commissioned to build for use on Mount Rose, a meteorograph capable of recording temperature, pressure humidity, and the direction and velocity of the wind during a period of six weeks with one winding of the clock. This instrument, after thorough trial at the University, was taken to the summit in the autumn of 1908. At first the record was frequently interrupted by snow, which penetrated the outer casing and clogged the mechanisms and it was not until December, 1910, that this trouble was remedied by the addition of weather-strips. Later these were replaced by a canvas jacket, which covers the instrument completely, excepting the wire cage in which are exposed the thermograph tube and hygrograph hair. In January, 1912, the clock was altered to run 90 days with one winding, although usually the record sheets are changed every six weeks or two months. Since 1911 the records of pressure, temperature, and relative humidity have been nearly complete for the entire year, and those of the direction and movement of wind complete for the summer months from May until October. Between October and May the anemometers are so frequently covered with ice and frost that the records cannot be depended upon. The performance of this instrument is considered satisfactory, making allowance for the severe conditions of temperature, moisture, etc., although experience indicates that, if the mechanisms were modified somewhat, it could be made much more accurate and the labor of caring for it lessened.

AUXILIARY STATIONS

Meteorographs of the same pattern, recording weekly instead of bimonthly, were placed at Truckee, Cal., and Fallon, Nev., in order to obtain low-level data for comparison with those recorded on Mount Rose. Nearly continuous records have been obtained from these stations since January, 1911, and there are available for further comparison the records from the U. S. Weather Bureau at Reno and from twelve thermograph stations mostly in the Truckee Valley near Reno.

In accordance with International usage atmospheric pressures are expressed in bars, air temperatures in degrees absolute, wind velocities in meters per second, and linear distances and heights in metric units. For the convenience of those unfamiliar with these units, the annual averages in Table I are given in English measures, and scales in English units are placed at the right side of each figure illustrating changes of temperature and pressure, etc. One bar = 0.0295 inch, one degree A. = 1.8° F., one meter per second = 2.24 miles an hour, one meter = 3.28 feet, and one kilometer = .621 mile.

THE CONDITIONS PREVAILING AT DIFFERENT HEIGHTS—RESULTS FROM MOUNTAIN OBSERVATORIES

Until within the past twenty-five years, nearly all our information regarding conditions in the upper air came from observatories on mountains, observations of clouds and occasional ascensions of free balloons. The discovery, from these sources, that the velocity or movement of the air increases with increase of height above the earth's surface led to the inference that changes of condition should occur earlier at considerable heights; and practically all systems of forecasting from upper-air data have been based upon this theory. Probably the first attempt to utilize upper-air data in forecasting was made by the U. S. Signal Service in 1871, when the station on Mount Washington, New Hampshire, was established. In 1873 another station was established on Pike's Peak, Colo., and the observations from both were telegraphed to the central office at Washington for publication in the daily bulletins. Other important experiments of this kind have been made at Ben Nevis Observatory in Scotland (established in 1882 and maintained by private subscriptions), and Mount Royal, Canada, in 1903 to 1906, by Professors McLeod and Barnes of McGill University, Montreal. Other mountain observatories, devoted entirely to research, have been established, of which some of the most important are those on the Pic du Midi, Puy de Dome, Sonnblick and Brocken, in Europe, and Blue Hill and Mount Weather in the United States.

Before presenting an analysis of the records from the Mount Rose stations, it is desirable to give a brief summary of what is known concerning the conditions prevailing at different heights and to review previous attempts to utilize upper-air data in forecasting. From the most important studies of these phenomena available there have been selected comparisons of records made simultaneously at the summit and base stations of the following mountains: [2]Mount Washington and Burlington, Vt.; [3]Pike's Peak and Colorado Springs, Colo.; [4]Fuji, Japan, and Yamanaka; and Blue Hill, Mass., summit and valley stations. All these results from widely separated mountain stations are compared with data obtained in the free atmosphere by means of kited and *balloon-sondes*.

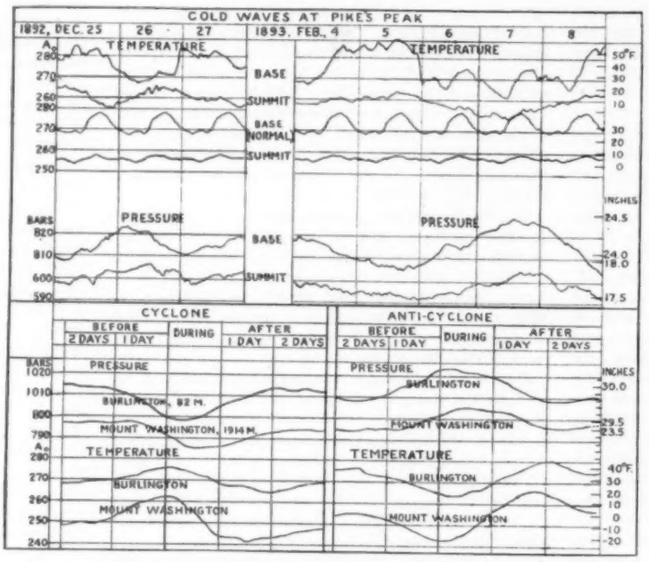


Fig. 1. Temperature and pressure in cold waves, cyclones and anti-cyclones

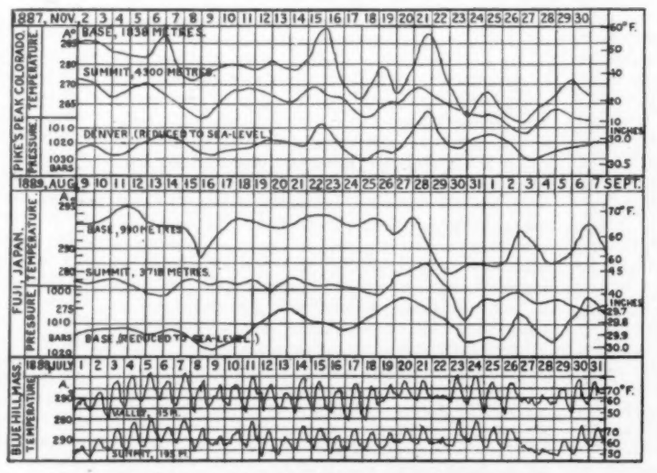


Fig. 2. Synchronous changes in temperature and pressure at summit and base stations

Mount Washington.—Mount Washington is in latitude 44° 16′ N., longtiude 71° 16′ W. The summit is 1,918 meters above the sea, from which it is distant 145 kilometers (90 miles) in a northwesterly direction. Burlington, Vt., used as a base station, is 200 kilometers west of Mount Washington and 67 meters above sea-level.

Of all mountains in the United States, Mount Washington is the most favorably situated for the study of phenomena of the general circulation of the atmosphere, since the two paths of greatest frequency of occurrence of cyclones converge in this region. The fluctuations of pressure, temperature and wind, due to the passage of cyclones and anticyclones, are very marked, and the violence of the winter storms experienced there has not been equaled anywhere, except perhaps in the Antarctic regions.

From a study of forty cyclones and forty anti-cyclones passing over Mount Washington, [4]Hazen reached the following results:

First.—In both cyclones and anti-cyclones the changes of pressure on Mount Washington lag from 10 to 11 hours behind changes at sea-level.

Second.—The temperature change at sea-level precedes very slightly the pressure change, but at the summit the change occurs nearly 24 hours earlier than the pressure change.

Third.—The temperature change appears to occur a very little earlier at the summit than at the base and certainly varies much more rapidly at the summit.

Fourth.—In the cyclone, the difference in temperature between the base and summit is less than the mean, but rapidly increases after the center has passed. Just the contrary is true in the anticyclone.

The data upon which these results are based are plotted in Fig. 1. The traces begin two days before and end two days after the passage of the center. Other very important discussions of records from Mount Washington have been published by [5]Hahn, [6]Dechevrens, [7]Clayton, and many others.

Pike's Peak, Colorado.—Pike's Peak is in latitude 38° 50′ N, longitude 105° 2′ W, and is 4,300 meters above sea-level. The base-station at Colorado Springs is only 17 kilometers (11 miles) east of the summit and is 1,858

*From Bulletin 83 of the University of Nevada Agricultural Experiment Station.

[1]Associate Meteorologist of the Nevada Agricultural Experiment Station and Professor of Meteorology and Climatology in the University of Nevada.

[2]From "Pressure and Temperature in Low and High," by H. A. Hazen in American Meteorological Journal, October, 1887.

[3]Blue Hill Observatory Bulletin No. 1, 1900, by H. H. Clayton.

[4]"Pressure and Temperature in Low and High"—American Meteorological Journal, October, 1887.

[5]Meteorologische Zeitschrift, April, 1887, and January, 1888.

[6]American Meteorological Journal, August, 1886.

[7]Blue Hill Observatory Bulletins, No. 1, 1899, and No. 1, 1900; and Beitrage zur Physik der frien Atmosphare, Band 1, Heft III. 1905.

meters above sea-level, or 2,442 meters lower than the summit. Until the opening of the Harvard College observatories in Peru, the Pike's Peak station was the highest in the world, and for many years the only continuous records at this height were made there. The observations and records from 1873 to 1888 were published *in extenso* by Pro. Pickering, Director of Harvard College Observatory, and, as in the instance of the records from Mount Washington, have been studied by eminent meteorologists, such as [8]Hann and [9]Dechevrens. In 1892 and 1893 continuous records of pressure, temperature and wind were obtained at the summit and at Colorado Springs and published in the Annual Report of the Chief of the Weather Bureau for 1893. These records were discussed briefly by Park Morrill in the Annual Report for 1896.

In Fig. 1 are plotted the actual conditions found in two cold-waves discussed by Morrill. The normal diurnal ranges are also plotted for comparison. These data were taken from the published hourly readings of pressure and temperature.

In Fig. 2 is given a comparison of the daily changes of temperature at Pike's Peak and Colorado Springs during November, 1887, together with the pressure at Denver (reduced to sea-level), there being no record of pressure at Colorado Springs at this time.

Recently, Prof. A. J. Henry of the United States Weather Bureau published another important study of the relation of the pressure and temperature at summit and valley stations in the Rocky Mountains to the prevailing weather conditions, using for this purpose data from Pike's Peak, Colorado Springs, and Denver (1,630 meters) on the eastern slope, Corona (3,554 meters) at the summit of "divide," and Fraser (2,609 meters) on the western slope of the main range.[10] From the summary of this paper the following paragraphs are quoted:

"In general, the temperature changes at high- and low-level stations are nearly synchronous in point of time and similarly directed, but in particular cases the temperature may rise at one station and fall at the other, or *vice versa*, although the horizontal distance between them is small.

"Any abnormal course of the temperature between a mountain station and a near-by low-level station can generally be explained by considering the pressure distribution over surrounding regions to a distance of at least 1,000 miles from the stations. The effect of topography on the interchange of air between cyclones and anticyclones is also to be considered.

". . . The connection between anticyclonic weather conditions and low night temperatures is unmistakable. The absolute cooling depends somewhat upon the position and movement of the anticyclone. The greatest lowering of temperature evidently occurs when an anticyclone occupies the region to the northwest of Fraser and stretches in an east-west direction from western Wyoming to southeastern Idaho with little movement of the center. The converse of the above, viz., little air drainage and reduced nocturnal radiation, occurs with strong winds, cloudiness, and general precipitation mostly in connection with the movement of an anticyclone southeastward from Montana along the eastern slope of the mountains, at the same time that a cyclone is central west of the mountains and southwest of Fraser.

"In general, the processes which cause a diminution of nocturnal radiation and consequently a high night minimum temperature at points situated like Fraser are the same as those which precede precipitation. Evidently, they have some prognostic value and it may be worth while to pursue the matter further."

Fuji, Japan.—Fuji (or Fujiyama) is in latitude 35° 30′ N, longitude 138° 40 = E, and the summit is 3,718 meters above sea-level. The base station, Yamanaka, is only 12 kilometers (7.5 miles) distant and is 990 meters above sea-level, or 2,728 meters below the summit. The data of pressure and temperature from these stations, plotted in Fig. 2, are from observations made daily at 8 P. M. and show the changes from day to day. The pressure record at the base station is reduced to sea-level and inverted for better comparison with the temperature. These data were taken from Blue Hill Observatory Bulletin No. 1, 1900.

Blue Hill, Mass.—Blue Hill is in latitude 42° 13′ N, longitude 71° 7′ W, and is 195 meters above sea-level. The valley station is 15 meters above sea-level and about 2,500 meters north of the hill. Here are practically the same conditions as exist at Mount Royal, in nearly the same region, since Blue Hill is only 280 miles south of Mount Royal, with the exception that the valley station is not sheltered by buildings and is on the northern instead of the southern side of the hill. The instruments of both summit and valley are in standard shelters and the record sheets, which are changed daily instead of weekly, are compared with standard instruments four times a day. The lower part of Fig. 2 contains plots of hourly temperatures at both stations recorded during July, 1888.

RESULTS FROM RECORDS OBTAINED BY MEANS OF KITES

Mountain observatories have yielded data of great value in meteorological studies, some of which cannot be obtained in any other way. However, as will be shown later, the conditions recorded near a mountain are influenced more or less seriously by the mountain itself and do not always indicate a condition of the free atmosphere. What may be termed precise knowledge of the processes of the upper air has come only within recent years with the development of the youngest department of meteorological research known as aerology, which practically originated in 1893 and 1894 with the use of light self-recording instruments lifted by means of *ballons-sondes* and kites.

The comparisons given below, of temperatures at different heights in the free atmosphere, are quoted from an analysis by Clayton of a large number of records obtained at Blue Hill Observatory by means of meteorographs carried by kites.

In the first of these studies[11] Mr. Clayton found that the vertical distribution of temperature varies from time to time and that these variations are divisible into a few distinct types. After describing one of these, which he terms the warm-wave type, he says: "This type may be found when colder air is pushing in from the east or north near the ground beneath an opposing warmer current; but in a large majority of cases, when found below heights of 2,000 meters, it is caused by the approach of a warm wave, the upper air of which, partaking of the rapid movements of the upper currents from the west, advances faster than the lower part of the warm wave and overflows the colder air in front. A knowledge of the existence of this type enables one to forecast the arrival of a warm wave with a high degree of certainy, from eight to twenty-four hours in advance."

Concerning the cold-wave type of temperature distribution, Clayton says: "The reverse of type 4 (the warm-wave type), that is, a sudden fall of temperature at a given height, due to a colder current overlying a warmer one, is probably impossible, because the colder air, on account of its increased weight, would immediately begin to sink and the warmer air to rise. This would cause the fall of temperature to take the adiabatic rate from the ground to the top of the colder current. . . . If, for any night on which the temperature fell rapidly as a result of an approaching cold wave, the thermograph records at the summit and valley stations of Blue Hill Observatory are corrected for instrumental errors and placed one over the other, the traces will be parallel, and the temperatures at the summit will be found lower than at the valley stations by almost exactly 1.7° C., which is the adiabatic rate of decrease between the two stations. At least, this condition was found in an examination of the records during a number of well-marked cold waves."

Stated in other words these records indicate:

(1) That during or preceding warm waves the rate of decrease of temperature with increase of height is relatively small and the rise of temperature below 1,000 meters is felt at the upper station (or elevation) some time before it appears at the ground.

(2) During cold waves, the rate of decrease of temperature with increase of height is very rapid, approximately the adiabatic rate of 1° C. for each 100 meters of elevation, and the cold wave apparently occurs at the same time at all levels within about 1,000 meters of the ground.

That results from one series or group of records are not entirely conclusive is indicated by the following extract from a study by Mr. Clayton of a larger number of records at greater heights, made in 1900:[12]

"The curves showing the changes of temperature at different heights indicate that the temperature changes are alike at all heights up to at least 3,000 meters; in other words, the warm and the cool periods occur aloft at the same time that they occur at the ground. The only partial exception to this was in the winter kite flights of February, 1900, when the cooling of the surface by radiation in the anticyclone caused the minimum temperature at sea-level to occur about twenty-four hours later than the minimum aloft. But, from the height of 200 meters to the height of 3,200 meters, the minima all occurred within a few hours of the same time."

RESULTS FROM RECORDS OBTAINED WITH BALLONS-SONDES

This method of exploring the higher regions of the atmosphere originated in France in 1893, and has been employed extensively in Europe and to a limited extent in this country, first by the Blue Hill Observatory in 1904 and by the Weather Bureau since 1906. A small sealed rubber balloon, carrying a recording instrument only, is liberated and rises until it is exploded by the internal pressure of the hydrogen with which it is filled. A parachute retards the descent of the balloon so that the instrument is not injured and a notice attached directs the finder to return the equipment to the experimenters, a small reward being paid for this service.

Great elevations, impossible of attainment by other means, are reached by these balloons, and in one or two instances records have been obtained a at height exceeding 30,000 meters. The data already obtained have profoundly altered our ideas concerning the upper atmosphere.

During the interval between 1904 and 1907 six series of ascensions of *ballons-sondes* were conducted at St. Louis by the staff of Blue Hill Observatory. The records, some of which were obtained at heights exceeding 15,000 meters, were analyzed and discussed by Mr. Clayton in the Annals of Harvard College Observatory, Vol. 68, Part 1, 1909, and elsewhere.[13] The daily changes of temperature and pressure at different heights up to 15,000 meters, or nearly 10 miles, in April and May, 1906, are well shown in Figures 3 and 4 taken from the publication mentioned above.

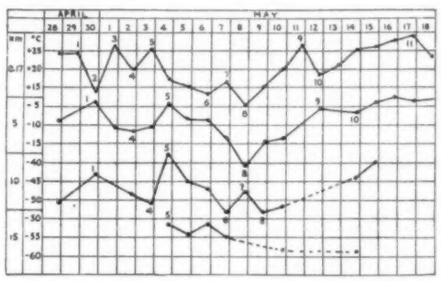


Fig. 3. Daily changes of temperature at different heights. From records obtained by means of balloons

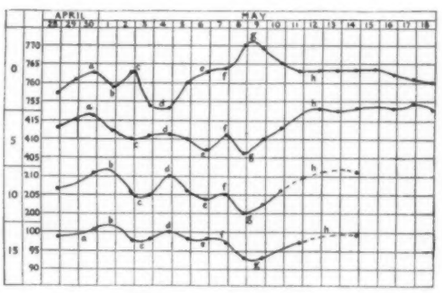


Fig. 4. Daily changes of pressure at different heights. From records obtained by means of balloons

Other Attempts to Predict by Means of Upper-Air Data

MOUNTAIN OBSERVATORIES AS FORECASTING STATIONS

Mount Washington and Pike's Peak.—In what has been referred to as the first attempt to utilize upper-air data in forecasting, observations of the principal meteorological elements were telegraphed two or three times daily from Mount Washington and Pike's Peak to the central office of the United States Signal Service at Washington and there published in the Daily Bulletins of the Service, together with data from other stations in different parts of the country. 'The reports from Mount Washington were continued from 1871 until 1887, and those from Pike's Peak from 1873 until 1882. It was found that practically no improvement in the forecasts resulted from the use of these reports, and later it was decided that, considering the difficulty of maintaining these stations, their contribution to meteorological science was small. The station on Pike's Peak was closed in 1888, but was reopened for the two years 1892 and 1893, during which time continuous records of pressure, temperature, wind, and precipitation were obtained. The station on Mount Washington was opened during the summer only from 1887 until 1892, and during the latter part of this time a barograph and a thermograph were in use. Before the year 1890 the only self-recording instrument at either station was an anemograph giving the movement of the wind; and, with the exception of a few periods of a month each when hourly observations of temperature and pressure were made, the only data relating to these elements available

[8]Meteorologische Zeitschrift, April, 1887, and January, 1888.

[9]American Meteorological Journal, August, 1886.

[10]Variations of Temperature and Pressure at Summit and Base Stations in the Rocky Mountain Region. (Bulletin of the Mount Weather Observatory, Vol. III, Part 4, December, 1910, and Vol. IV, Part 3, November, 1911.)

[11]"Exploration of the Air by Means of Kites." (Annals of Harvard College Observatory, Vol. XLII, Part 1, 1897.)

[12]Blue Hill Observatory Bulletin No. 1, 1900.

[13]Monthly Weather Review, March and October, 1907, and Beitrage zur Physik der frein Atmosphare, 1905, Band 1, Hwft III.

for study are "eye" observations made three times daily, and, for a few years, five times daily.

Ben Nevis. In 1883, another important experiment in forecasting from high-level data was begun at Ben Nevis Observatory in Scotland. The following description of Ben Nevis is quoted from "The Meteorology of Ben Nevis," by Dr. Alexander Buchan of the Scottish Meteorological Society:[14]

"In 1877, Mr. Milne Home, then Chairman of the Council of the Scottish Meteorological Society, pointed out the singular advantages of Ben Nevis as a high-level observatory. It is the highest mountain in the British Islands, rising to a height of 4,406 feet (1,343 meters) above the sea; its summit is, in horizontal distance, about four miles (six kilometers) from a sea-level station at Fort William; and it is situated in the track of the southwest storms from the Atlantic, which exercise, particularly during the coldest months of the year, so preponderating an influence on the weather of Europe. These, and other advantages, to be afterwards referred to, offered by Ben Nevis, as a high-level meteorological observatory, are therefore unique, and it was at once recognized that observations made there would prove of the greatest value to meteorology."

On account of the severe conditions prevailing on Ben Nevis, self-recording instruments could not be used there, but, notwithstanding this, the record, beginning in 1883 and continuing during twenty years, is probably the most complete and most accurate ever obtained at a mountain observatory. It consists entirely of "eye" readings of standard instruments and notes of optical phenomena made every hour day and night during the entire period of time. In 1890 a well-equipped base station was established at Fort William, 29 feet (9 meters) above sea-level, and 1,334 meters lower than the summit.

The observations were published in the daily reports of the British Meterological Office and the records have been published *in extenso* and discussed by Dr. Buchan in two large volumes of the "Proceedings of the Royal Society of Edinburgh." The cost of maintaining the observatories has been met almost entirely by public subscriptions.

Concerning the relation of the Ben Nevis observations to weather changes, Dr. Buchan states: ". . . So far as the investigation has gone, it is clear that considerable and especially rapid changes from the normal differences of pressure and temperature are frequent concomitants and precursors of storms, but more particularly of destructive winds during storms. Of these departures from the normals, the most important are the cases that show an unusually rapid decrease of temperature with height—a result which is only what was to have been expected, seeing that such observations indicate a disturbance of the equilibrium of the atmosphere. . . . If there be conjoined with an unusually rapid rate of decrease of temperature with height a lower sea-level pressure, calculated from the Ben Nevis readings, than what is actually observed at Fort William; that is to say, when the barometric observations indicate a more rapid decrease of temperature with height somewhere in the aerial stratum between sea-level and the top of the mountain than the thermometric observations alone show, then the indications of a coming storm become more decided. Conversely, the absence of any abnormally rapid decrease of temperature with height, as may be ascertained from all the observations, is rarely attended or followed by storms of wind."

Apparently, however, these and other less definite relationships between the records and current weather conditions did not prove to be of practical value in forecasting, for, in 1902 or 1903, the telegraphic reports from Ben Nevis were discontinued.

Mount Royal.—The most recent attempt to forecast from high-level data was made by Professor McLeod and Dr. Barnes of McGill University, Montreal, Canada. A Callendar electrical resistance thermometer was placed on the summit of Mount Royal and connected with a registering apparatus at the University Observtory in the plain below. In the same circuit was placed a similar thermometer exposed in a standard shelter on the University grounds. The recording apparatus was so arranged that the pen recorded continuously the difference of temperature existing between the upper and lower stations. The station at the summit is 244 meters (800 feet) above sea-level and 620 feet (189 meters) above the base station, from which it is distant, horizontally, 1,005 meters. The cable connecting the two stations is 4,100 feet (1,250 meters) in length. The records were begun in July, 1903, and continued intermittently until April, 1908, and have been discussed by Professors McLeod and Barnes in four papers published in the "Transactions of the Royal Society of Canada."[15]

The authors found that "temperature changes affect the high-level thermometer first, and that the time interval between the first indication of a change and the change at the lower level varies from four to twenty-four hours. So accustomed are we now to follow the changes that it has become a matter of common observation with us. The following conditions have been observed to hold fairly accurately:

"(1) Steady positive difference (of temperature between upper and lower stations, a positive difference meaning that the temperature at the upper station is higher) shows weather conditions growing milder.

"(2) Increasing positive difference, or decreasing negative, indicates a change to milder weather.

"(3) Decreasing positive difference means steady temperature conditions possibly growing colder.

"(4) Increasing negative difference indicates temperature conditions growing colder at the lowel level.

"(5) Steady negative difference indicates steady and continued tem.erature conditions at the lower level.

"As an example of the way our records afford a means of forecasting the temperature conditions of the next day, we include the following table of predictions, taken from the April (1908) records:

"It (the table) is from a careful study of the general variation of the differences for each daily chart, as well as from the actual magnitude of these differences. No single observation at any one time can give anything like as accurate a prediction as a general examination extending over several hours. We always have to consider what has happened before going back over as much as twenty-four or even forty-eight hours by inspection of the continuous variations in the temperature gradient in the lower strata of the atmosphere."

TABLE I

April, 1908	Prediction from Chart of Differential Recorder	Actual Change in Temperature on Following Day Shown by Thermograph Record	Per cent of Verifications
2	Little colder	About 10°F. colder	50
3	Continued cold to little colder	About 2° or 3° colder	100
4	Not much change in temperature to warmer	Warmer	50
5	Warmer	About 8° warmer	100
6	Not much change	About same average temperature	100
7	Decidedly colder	About 20° colder	100
8	Not much change	Not much change	100
9	Cooler, followed by warmer	Warmer	50
10	Warmer	Not much change	0
11	Cooler	Cooler	100
12	Not much change	Not much change	100
13	Not much change	Same average temperature	100
14	Warmer	Warmer	100
15	Warm at first, then colder	Colder	50
16	Not much change; warm waves	About 20° warmer	50
17	Warmer	Warmer	100
18	Not much change	No change	100
19	Colder	Colder	100
20	Same temperature (cooler)	Cooler	50
21	Cooler, followed by warmer	Cooler, followed by warmer	100
22	Warmer	About 20° warmer	100
23	Warmer	Warmer	100
24	Warmer	Warmer	100
	Mean percentage verified		78

To this table the present writer has added a column of varifications, although, in the absence of definitions for the terms "colder," "warmer," "not much changed," etc., and of data as to the length of time in advance the predictions were made and the period of time covered by them, a satisfactory method of estimating success or failure cannot be devised. The explanatory note given above indicates that these predictions were based upon consideration of the changes of condition at the two stations for some time—in some cases two days—before the time of making the prediction, as well as upon the indications of the differential record at the time. No data are given of normal conditions and departures either of temperature at the upper and lower stations of the current differences, and the records of temperatures published for comparison are read and computed from the differential record instead of from independent instruments. Although in some cases they were taken from thermographs as well as from the differential record, the average differences between the upper and lower stations appear to be rather large, and suggest errors of exposure, which naturally are important when the difference of elevation is small. These matters will be considered in detail in the discussion of the accuracy of meteorological data presented hereinafter.

THE MOUNT ROSE STATIONS

Description, Position, Etc.—Mount Rose is in latitude 39° 20′ N, longitude 119° 50′ W, and the summit is 3,292 meters (10,800 feet) above sea-level, according to the United States Geological Survey. It is near the eastern side of the main range of the Sierra Nevada Mountains and about 25 miles (40 kilometers) distant from the crest or "divide," which at Summit on the Southern Pacific Railroad is 2,138 meters (7,018 feet) above sea-level. Between the crest and Mount Rose is the wide valley of the Truckee River, the irregular floor of which is at an average elevation of about 1,800 meters. South and southwest of Mount Rose the country is very rugged, and there are many peaks exceeding 2,500 meters in height. The northern shore of Lake Tahoe, 22 miles long, 12 miles wide, and 1,896 meters above sea-level, is 15 miles south of Mount Rose. On the eastern side, from southeast to north, is the Carson Valley, 15 miles wide, the floor of which is between 1,400 and 1,600 meters above sea-level.

Mount Rose is the highest part and the southern end of an irregular ridge, extending from the ravine of the Truckee River on the north to a deep ravine on the south between Mount Rose and Slide Mountain (2,900 meters), a distance of 14 miles. The highest peak is separated from the main ridge or *massif* by a notch or pass not more than 200 meters deep. On the west, south, and east sides the slopes are steep, averaging about 30°, while on the north they are usually less than 25°. Up to about 2,800 meters the sides of the mountain are sparsely covered with Alpine white pine; in the next 200 meters the trees rapidly become stunted or dwarfed, and above 3,000 meters the only vegetation is thin scrub in scattered patches. The surface of the slopes below 2,500 meters is mostly loose granite sand, which gradually is replaced by loose blocks, of small size, of granite, slate, and lava. The actual summit of Mount Rose is a sharp irregular ridge about 1,500 meters long, extending in an ESE-WNW direction. The shelters for the meteorograph and thermometers are on the highest part of this ridge, near a stone monument erected to mark the actual summit. The observatory building is set in an excavation in the summit-ridge and projects through it from one side to the other. It is about 5 meters below the summit. Near the meteorograph shelter is a large tank, with funnel protected by means of a Nipher screen, intended for use as a precipitation gage.

The station at Truckee, Cal., is in the valley of the Truckee River, on the southern slope of a mountain ridge and is 1,825 meters above sea-level and 40 meters above the river. To the east and south is the valley of the Truckee, extending 20 miles to the base of Mount Rose, and to the west is the summit ridge of the Sierra Nevada 7 miles distant. The conditions recorded here are those peculiar to mountain valleys—large diurnal ranges of temperature and the usual daily reversal of the direction of the wind from and toward the mountains.

The station at Fallon is near the middle of the large flat valley known as the Carson Sink and at least 10 or 15 miles distant from the nearest mountains. The elevation is 1,208 meters (3,965 feet) and the station is 60 miles (97 kilometers) east of Mount Rose. For recording surface conditions at this level this site is probably the best that can be obtained, and it is the only one on this region known to the writer where the true direction and velocity of the wind, uninfluenced by mountains, can be observed.

(To be continued)

Modifications in the Dilatability of "Invar" Produced by Mechanical and Thermal Treatment

FOR commercial uses, "invar" (a nickel steel containing approximately C 0.5, Mn 0.5, Ni 36 per cent) is usually rolled at a cherry-red heat and cooled in air. The present investigation was made to determine the effects of annealing, quenching, and cold working on the dilatability of the alloy as ordinarily supplied. The coefficient of expansion was increased by annealing for several hours at 900 degrees C. and cooling in air or in the furnace, and decreased by quenching in water, the range of variation from these causes being 1.18×10^{-6}. By cold drawing the annealed or quenched alloy, the dilatability was rapidly decreased, the combined effects of the thermal and mechanical treatments being to reduce the original co-efficient of expansion by 2.18×10^{-6}. The dilatabilities of quenched rods and cold drawn wires, already 0.49×10^{-6} and 1.50×10^{-6} below that of the alloy as commerically supplied, were increased by 0.42×10^{-6} and 0.80×10^{-6} respectively, by prolonged heating at temperatures up to 250 degrees C.; whereas the dilatability of the alloy in the "natural" (as supplied) or annealed condition was scarcely affected by this treatment. From the results obtained it is concluded that the effect of cold drawing on the dilatability of commercial "invar" is practically neutralized, and the alloy stabilized as far as geodetic requirements are concerned, by prolonged heating at 100 degrees C.—*C. H. Guillaume in Comptes Rend. From a note in the Journal of Society of Chemical Industry.*

[14] Proceedings of the Royal Society of Edinburgh, Vol. XXXIV, 1890.

Weighing Apparatus in Industrial Plants*

Suggestions for the Selection and Maintenance

By Fritz Reichmann, Ex-State Superintendent of Weights and Measures of New York

THE ultimate object of every industrial plant is to secure profits on every one of its manufacturing operations. It is therefore necessary to keep the cost of production down to the lowest possible limit consistent with proper manufacture and to raise the selling price to the highest point that the market will stand. This bare statement of fact may be, and is glossed over or veneered in many ways, generally for popular consumption. The selling prices are often fixed by competition or by agreement. Some may cite anti-trust laws as preventing this, yet it takes very little reasoning to see that such laws are economically unsound. They serve only to help a few lawyers and individuals and furnish a medium for official favoritism and possibly temporary notoriety, but in the end they result only in bringing about a most deplorable contempt for statute law.

In this paper I shall not attempt to discuss selling, but only a certain phase of the problems of production. The individual plant must be concerned with economical production. This means that among the many factors to be considered is the quantity factor, the careful, quick, reliable determination of quantity at various stages of production, from the reception of the raw material to the point of selling. This is a phase of weights and measures with which the public official is not concerned, at least not under any law now existing. Effectively he never will be concerned therewith. The simple reason is that official regulative inspection is and will remain, under our system of government, in the sphere of politics to a considerable extent. Governmental efficiency supervision of private industrial plants is ethically and economically wrong and is doomed to failure. It is attempted now and then for the sake of notoriety—witness the costly and ineffective so-called efficiency bureaus being experimented with by the city of New York, which interfere with business. Ultimate failure results because political activities should be for the general public and the ultimate consumer and should not be for and by the business man primarily. Make the results of the business meet the consumer's welfare and do not have the official officially fit the consumer to the dictates, carefully and insiduously given to be sure, of the business man.

Through the courtesy of Harvey Miller, of the Fairbanks Co., I have recently had an opportunity to examine in detail various kinds of weighing and measuring instruments used in industrial plants and to assist the manufacturer in solving some of the problems causing money losses due to improper weighing and checking. I would like to interject right here that this work which I am doing and which I call scale, or weights and measures insurance, is absolutely divorced from sales and is independent of the type, make, or size of the apparatus. I am only concerned with its proper use and its continuing accuracy for the benefit of the manufacturer and the business man, that he may thereby furnish to the consumer a better and more nearly correct product. In this wise it is helping the weights and measures official and also the food official.

The average manufacturer and business man is so much concerned with other problems that he neglects the details of his scales and balances, his weights and measures. He wants them right, to be sure, but he knows nothing of them and assumes (oh, woeful assumption!) that a scale is a scale and a pound a pound and that they are always right. He generally leaves to an underling the purchasing of his scales, though they meter the dollars into his till or determine the uniformity of his product. To be sure, he sometimes employs efficiency experts or efficiency engineers (often a most expensive luxury), but they are mostly accountants and know about as much about scales and weighing as a barber knows about the construction or adjustment of a chronometer or other astronomical instrument.

The business concern must consider:

(1) Devices for checking the receipt of materials.

(2) Devices for checking the manufacture or interdepartmental records.

(3) Devices for putting up and selling.

In most instances these devices are scales, and the particular type, size, and accuracy required depend on the nature of the product and the process of its manufacture. Certainly, for an expensive commodity a more accurate device should be used than for an inexpensive one; for a heavy, concentrated commodity a different type than for a bulky one. A note of warning must be raised against many of the automatic and dial scales. They are not a "cure all," and their complication involves sources of error and loss absolutely prohibitive in some instances. Whatever device is used and wherever it is used it needs careful consideration and constant attention and supervision, not only as to the instrument itself but as to its use; for weighing instruments, it should not be forgotten, are very precise and responsive, far more so than almost any other machine.

In my very first report as superintendent of weights and measures of the State of New York, I emphasized that the majority of business men were honest but often careless. Where errors occur due to weighing, the business man generally is the loser, and, mind you, the loss is a percentage loss of gross receipts, not a percentage of the profits only. If, for instance, on a $100,000 volume of business, with a nominal profit of $10,000, the scales were 2 per cent inaccurate the loss would be $2,000 and not simply $200. In short, with correct scales the profits on this business would have been $12,000 instead of $10,000, or 20 per cent higher.

It may be stated as a positive fact that every concern that uses scales or any kind of measuring instrument, subject to wear, needs an expert supervision by a disinterested party with specific and particular technical knowledge. It must be evident that for very good psychological reasons an employee of the concern itself will not suffice. In order to illustrate and make myself clear, I shall cite a few instances.

Case 1. A factory making hardware specialties: In one department small bolts were put up and a count of the boxes revealed the fact that there was an average of 3.25 per cent overcount. As the production was 12,000,000 of these bolts a month, at a selling price of 22 cents per hundred, it can readily be seen that the concern was giving away over $800 a month on this item alone. In this case, though the scales were correct, the weighing was carelessly done by cheap labor. Even the manufacturer did not realize that a few extra bolts meant so large a loss. This is now corrected, and the weighing matters are regularly attended to.

Case 2. A wholesale drug house: This concern was of the highest reputation and was using scales of entirely too large a capacity and old weights with the openings filled with various accumulations. These were used for putting up 1-ounce packages of drugs. In the case of an order for 600 1-ounce bottles of ipecac, too large a bottle was used, and the amount put in each bottle was more than 30 per cent overweight. Ipecac was worth $1 an ounce. It was not hard to convince the officials of this company that it would be a paying investment to have all their weighing instruments under a periodic supervision. No wonder the business concern had never had a complaint. Almost anyone ought to be satisfied with 25 to 30 per cent overweight.

A similar case was that of a jewelry house, whose troy weights were heavy, and consequently gold was being given with each shipment or sale.

Case 3. A fertilizer plant: The bagging scales had recently been repaired by one of these so-called itinerant scale mechanics who infest some sections and know no more about a scale than a lawyer does. A test showed that there was an error of 1½ per cent on the scales, and in their use there was an overweight of an additional 1 per cent given, which meant a loss to the concern on its production of thousands of tons of an expensive fertilizer, of a very considerable sum. This is now remedied, and a regular inspection assures its nonrecurrence.

Case 4. Several coal yards: In the coal business the scale gages the returns directly in terms of dollars and cents. These need attention regularly. Many equipments are all but ruinous to the dealer on account of irregularities in weighing. A number of these show an error of 50 pounds per ton, and this coupled with "up weighing" cause considerable loss on the tonnage. A number of coal dealers in New York city and vicinity now have their scales gone over carefully and systematically every month by a scale mechanic to protect themselves and their customers. There still persists the unfortunate and vicious system of "official public scales," probably without any legal foundation. (The losses due to lack of proper supervision and weighing in coal yards was discussed at length in the *Coal Trade Journal* (New York) of Mar. 1, 1916.)

Case 5. A large coal dealer: One of the largest coal dealers has no periodic test or adjustment. The weighmaster of the individual yards is instructed by the owner to put a 50-pound weight on the scale every morning. This is about as effective as spitting on the platform would be. I made an investigation on some dozen or more of the weighings, and if all were like these, then the officers of this particular company were losing for the company about $20,000 per year. This is simply lack of appreciation of the very essentials of their business and is causing considerable loss.

Case 6. A factory making underwear: In this case the weights were worn and the jack spinners were receiving too little pay for their work. They are paid by the weight of the yarn they spin; the finer the yarn the more the payment per unit. As the weights were light the apparent unit weight was more and the spinner's pay was less. This was a case of a loss of thousands of dollars for the employees and the loss of thousands on the part of the employers on account of the dissatisfaction created. This condition has been remedied.

Case 7. A chemical plant: The work done was of such a nature as to be very hard on the weighing devices and there was a continual scourge of error and disagreement. The firm had installed expensive dial scales and were thereby really throwing money away in the first instance and getting poor results. What they needed to do and did do, was to buy less expensive but more accurate beam scales and then replace them frequently as they became corroded.

Case 8. A specialty manufacturing concern: This firm makes celluloid specialties. They use scales to check interdepartment operations. The commodities handled are worth over a dollar a pound. The scales were found to be out of agreement by as much as 7 pounds. It can be readily seen that the records of the department needed considerable doctoring before they could be made to agree. The system of records created expense and chaos where it should have occasioned savings and order. This has been nicely straightened out.

Case 9. A metal manufacturer: A plant in New Jersey making an expensive and much advertised alloy metal had a small scale on which rods were sold at 80 cents per pound. The scale was barely sensitive to 2 pounds. A large dormant scale for weighing large castings was insensitive to 50 pounds. The castings sold for 40 cents per pound. This concern, after having their attention called to the case and being shown that there were considerable losses to them had some temporary repairs made, I believe. They will go along now losing money for the stockholders until the scales become too bad, and then again temporary repairs. The equipment needs decided changes, but at present they are too prosperous to realize their "slipshod" methods.

Case 10. A paint and color factory: Here there was a considerable loss due to gummed pivots and bearings as well as to woefully improper scales. The products are valuable and the management intelligent and they want the scales in their factory gone over regularly.

Case 11. A special chemical product plant: In this plant commodities worth $40 a pound were weighed on scales that were correct to the smallest graduation, but the finest graduation was only a pound. There was a possible error of $40 on each weighing.

I could go on enumerating all sorts of business concerns—feed dealers, cheese dealers, grocers, hair dealers, manufacturers of all sorts of metal goods and chemicals, drugs, varnishes, and paints. The above few cases illustrate the point that I want to emphasize. Every concern in its business needs some sort of weighing or measuring device, and above all needs to know that it is correct and correctly used; needs disinterested technical advice as to the proper kind to use and advice based and backed by practical knowledge. I also wish to emphasize that such work of proper supervision does help the consumer or purchaser, and

*From a paper read before the Eleventh Annual Conference on Weights and Measures by Fritz Reichmann, Ex-State Superintendent of Weights and Measures of New York.

that is the one that the official is concerned with and the only one he should be concerned with. If he is not, he is a poor public official and will not accomplish much. I am speaking now of the officials carrying out regulative laws, not scientific or technical bureaus, which serve an entirely different function. There are no such bureaus in any of the States as far as weights and measures are concerned.

Also to the business man I would say that the weights and measures official is doing a lot of good in apprehending the crook; doing good not only for the ultimate purchaser, but also for the honest business man. But the public official can not protect the business man in the matter of weights and measures in the organization of his business nor in the conduct thereof. The business man must do that himself, and if he does not do it properly or wisely he loses, and loses more by the giving of overweight than in any one thing.

In conclusion I wish to summarize by stating that the State or city or county weights and measures official can not test the scales and weights and other metering devices of a business concern often enough for the business man's protection. He can only hope to do something in apprehending the thief who mulcts the consumer. Every business man who has any use at all for scales or other metering devices can certainly save, and thus make a very considerable amount of money by having these devices periodically tested and adjusted by experts in that line, and stopping the leaks as soon as possible, for it is the daily and the hourly visible and invisible leaks that cause the greatest losses.

Linking up Electric Supply Lines

ACTIVE steps are now being taken in various directions with a view to bringing about as much interconnection as possible between electric power stations. The need for linking up the stations in different districts has often been considered, but it is only recently that the full advantages have been generally appreciated, and that the problem has been attacked on broad lines. In this way lies not only economy in fuel, but safety to many vital national industries. Though there are so many differing voltages and alternations at which electricity is supplied, it is fortunate that the great majority of stations in this country generate three-phase current at 50 periods, so that the problem of interconnecting is relatively simple. But there is a number of large systems which generate at 25 and 40 periods, several generate at 60 periods, two large stations generate at 33 periods, while a considerable number generate at other frequencies. These last are principally single-phase systems. The problem of linking up systems of different frequencies is much more complicated than that of linking up systems of the same frequency, and each particular case requires careful consideration in order to determine the best method to adopt.

At the last meeting of the Institution of Electrical Engineers Mr. John S. Peck dealt very ably with many of these cases. He pointed out that when two alternating-current generators having the same number of poles and the same rating are operated in parallel, they must, of course, run at exactly the same speed, and, if they are to divide the load equally, it is essential that the two engines for turbines driving them should have the same speed regulation, *i. e.*, the same drop in speed from no load to full load. If one engine should have a regulation of 2 per cent and the other of 4 per cent then (assuming the regulation curve to be a straight line) with full load on one generator there would be only half-load on the other. In other words, the load carried by the generator is determined by the amount of steam admitted to the engine, and not, by the adjustment of the field strength of either machine, *i. e.*, the load depends on the governor and not on the position of the field rheostat. Any two machines may be made to divide the load in any desired proportion by proper adjustment of the steam supply, while adjustments of the field rheostats simply cause wattless currents to flow between the generators. The effect of this current is to strengthen the field of the overexcited generator; thus the voltage across the two remains equal.

When the stations to be linked up have the same frequency, voltage, and phase, the only interconnecting link required is a cable with the necessary switches, etc., for connecting together the busbars of the two stations. It often happens, however, that the voltages of the two stations are not exactly equal, and it may be required to vary the voltage of either station independently of that of the other. For this reason it is desirable to have some form of voltage regulator in at least one of the stations; otherwise, when voltage adjustments are attempted, heavy wattless currents will flow between the stations and the voltages on the two systems will remain equal, except for the difference due to the drop of pressure in the cable. The regulator may be either of the step-by-step or of the induction type.

It is common practice to operate electro-hydraulic systems of the same frequency in parallel, and on the Continent and in America many large transmission networks are supplied from stations located long distances apart. In Great Britain an increasing number of systems of the same frequency are being operated in parallel, but there has been very little done towards linking up systems of different frequencies.

In South Wales a 40-cycle system is operating in parallel with a 50-cycle system through two 500-kilowatt induction motor-generators. One set has a 40-cycle induction motor and a 50-cycle synchronous generator. The other has a 50-cycle induction motor and a 40-cycle synchronous generator. These sets have worked very well in service, except that the heavy wattless currents taken by the induction motors limit the output of the stations and cables. A synchronous condenser is being installed which may work on either system.

In France and Italy there are some large systems of different frequencies connected through motor-generators. Mr. Peck gave some most useful particulars of a very interesting installation at Savona, Italy, where a synchronous set is used for linking up two very large systems—one of 16 2-3 periods and the other of 50 periods. The synchronous set consists of two 10,000 k. v. a. generators, one having two poles and giving a frequency of 16 2-3 cycles, and the other six poles with a frequency of 50 cycles. Synchronizing is usually done by first synchronizing the turbine with the 50-period part of the plant, and afterwards with the 16.6-period part, the latter operation being very easy. Only from time to time is it necessary to telephone to other stations to adjust the speed.

In this case the two machines are coupled to a steam turbine. The original plan was to use the set for feeding either or both systems, but as coal is now at an almost prohibitive price in Italy, the set does excellent service as a frequency changer.—*The London Daily Telegraph.*

Physical Geography of the Southern Algerian-Moroccan Frontier

A CLASSIFICATION of this borderland into natural regions has been obtained by Francis Rey, a French army officer, by combining geological and geographical observations made in the course of explorations undertaken between the years 1910 and 1912 (Recherches géologiques et géographiques sur les territoires du Sud Oranais et du Maroc sud-oriental, *Revue de Géog.* Vol. 8, 1914-1915, 175 pp.). The area investigated embraces nearly forty thousand square miles and is included between the parallels of 30 degrees and 33 degrees N. and the meridians of 0 degrees and 5° W. Three main regions are distinguished. The steppes and the Shott Tigri form the most northerly. The mountainous intermediate region of the Saharan Atlas follows, while a southern region comprises the zone of *hammadas*, or Saharan plateaus.

The steppe region has an altitude varying between 3,600 and 4,600 feet. Originally a folded area similar to the Saharan Atlas, it has been transformed into a number of desertic peneplains. These forms are shown to be the result of five successive cycles of erosion, characterized by a persistent conflict between eolian and alluvial agencies. The transition from this natural region to that of the Saharan Atlas occurs without a break. Mountain features merge insensibly into those of the desertic peneplain type.

The distinctiveness of the Saharan Atlas is due to structure. In the west the mountain region shades off into that of the Moroccan Atlas. The area investigated by Rey is subdivided into three sub-regions, namely, the Tamlelt elevated plain, the Ksur and Figuig ranges, and the Moroccan Ksur ranges. The Tamlelt plain lies at an average altitude of about 3,900 feet. Its greatest length strikes east-west. In places upon its sandy surface, saucer-like depressions with a clayey bottom form the sites of oases with sparse verdure. Life in the region is centered around these patches of green. Beyond lies the bare plain with its Saharan flora. The Ksur mountainous region presents the appearance of an elevated plateau supporting a system of roughly parallel ranges. The altitude of the intervening plains decreases from north to south. Thus the descent into the *hammada* zone follows in steplike sequence. The Figuig ranges differ from the preceding in geological character. Jurassic limestones almost exclusively compose the rock strata. The folding is of a distinct Alpine type with upturned anticlinals, whereas in the Ksur region it is Jurassic in character. The limestone foundation combines with the desertic climate to convert the region into a land of desolation.

South of the Atlas the *hammadas* form a region which has been subjected to powerful erosive agencies. Beginning at the end of the Tertiary successive layers of this desertic formation have been deposited. Their surface is devoid of life and conveys an excellent impression of the Saharan desert. As a rule they are slightly tilted toward the south.

Special mention of the influence of eolian action is made in the course of this study. It is shown that, while the wind has exercised a destructive action in the northern zones of steppes and mountains, its effects have been constructive in the southern *hammadas*, where thick layers of sand have been deposited over landforms modeled by river erosion. The sand dunes, or ergs, carved by the wind thus provide a system of forms due to eolian action which overlie a morphological series due to river erosion.

From an economic standpoint the region is one of meager resources. Sheep raising constitutes the most profitable occupation on the plateaus, and hopes are entertained of the possibility of creating a dry-farming industry. Mining may become an important source of revenue in the Atlas country.—*Geographical Review.*

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, MARCH 31st, 1917

Published weekly by Munn & Company, Incorporated. Charles Allen Munn, President; Frederick Converse Beach Secretary; Orson D. Munn, Treasurer; all at 233 Broadway, New York

Entered at Post Office of New York, N. Y., as Second Class Matter

Copyright 1917 by Munn & Co., Inc.

The Scientific American Publications

Scientific American Supplement (established 1876) per year $5.00
Scientific American (established 1845) 4.00
The combined subscription rates and rates to foreign countries, including Canada, will be furnished upon application
Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 233 Broadway, New York

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

Back Numbers of the Scientific American Supplement

SUPPLEMENTS bearing a date earlier than January 1st, 1916, can be supplied by the H. H. Wilson Company, 39 Mamaroneck Avenue, White Plains, N. Y. Please order such back numbers from the Wilson Company. Supplements for January 1st, 1916, and subsequent issues can be supplied at 10 cents each by Munn & Co., Inc., 233 Broadway, New York.

WE wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject matter involved, or of the specialized, technical, or scientific knowledge required therefor.

We also have associates throughout the world, who assist in the prosecution of patent and trade-mark applications filed in all countries foreign to the United States.

MUNN & Co.,
Patent Solicitors,
233 Broadway,
New York, N. Y.

Branch Office:
625 F Street, N. W.,
Washington, D. C.

Table of Contents

	PAGE
World Wide Changes of Temperature.—By Charles F. Brooks	194
Harnessing a Volcano to a 15,000 H.P. Electric Power House	195
French Legislation Upon Hydraulic Plants	195
The Cohune Palm.—By C. D. Mell.—3 illustrations	196
The Laundries of the Ancients.—By Henri Rousset.—3 illustrations	197
Origin and Culture of the Navel Orange	197
Importance of the Relation of Solid Surfaces and Liquid Films in Some Types of Engineering Construction.—By Clifford Richardson	198
The Hippocampus	199
Passive State of Metals	199
Hard Rubber Sponge	199
New Work for Women Created by the War.—5 illustrations	200
German Aeroplanes in the War	200
The Training of the Analyst.—By Frank Browne	201
Measure of Atmospheric Pressure	201
The Influence of Some Elements on the Mechanical Properties of Steel	202
The Contamination of Running Water with Tubercle Bacilli	202
A New Horned Snake	203
Boiler Efficiency	203
The Value of High-Level Meteorological Data.—I.—By S. P. Fergusson.—4 charts	204
Modifications in the Dilatability of "Invar" Produced by Mechanical and Thermal Treatment	206
Weighing Apparatus in Industrial Plants.—By Fritz Reichman	207
Linking of Electrical Supply Lines	209
Physical Geography of the Southern Algerian-Moroccan Frontier	209